Waddell Dam
(Pleasant Dam)
Phoenix Vicinity
Maricopa County
Arizona

HAER No. AZ-11

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

Historic American Engineering Record
National Park Service
Western Region
Department of the Interior
San Francisco, California 94102

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HISTORIC AMERICAN ENGINEERING RECORD

Waddell Dam
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Location:	Waddell Dam is located on the Agua Fria River in northern Maricopa County, Arizona. It is approximately thirty-five miles northwest of Phoenix. USGS 7.5' quad map titled Baldy Mountain. UTM coordinates: Northing: 12292047.1217 and Easting: 1256071.7995 (both in feet).
Date of Construction:	Diversion Dam 1891-1895, Diversion Dam, Waddell Dam and canal 1926-1927, and intermittent through 1936.
Engineers:	Diversion Dam by George and William Beardsley, Waddell Dam by Peckham and James.
Present Owner:	Maricopa County Municipal Water Conservation District Number One.
Present Use:	Waddell Dam presently stores Agua Fria River water for use by the Maricopa County Municipal Water Conservation District Number One.
Significance:	Waddell Dam, formerly named Pleasant Dam, is the only water storage dam constructed by private interests in central Arizona. It became the largest multiple arch dam in the world upon completion.
Historian:	David M. Introcaso, Salt River Project Research Archives.

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The History of Water Storage Development on the Agua Fria River: The Construction of Waddell Dam

Chapter I, Introduction

Lands comprising the Maricopa County Municipal Water Conservation District Number One are located west of the Agua Fria River in the Salt River Valley in central Arizona. (See Appendix 1.) Like the American Southwest generally, the Salt River Valley is excessively arid with annual precipitation below ten inches. Temperature readings can range from near freezing to more than one hundred degrees Fahrenheit. Inadequate rainfall makes the area naturally inhospitable and in its unaltered state, this region could support only a marginal population. The construction of storage dams, however, permitted settlement and sustained growth in the Valley despite its severe desert environment. By constructing a storage dam, the Maricopa Water District regulated the Agua Fria River and succeeded in allowing more permanent development.[1]

The construction of Waddell Dam on the Agua Fria River by the Maricopa Water District and its precursors was part of the extensive effort to develop the scarce water resources of central Arizona. The success of the Agua Fria project, however, is unique in the Salt River Valley. Formerly named Pleasant Dam, Waddell, completed in 1927, is the Valley's only local water storage facility successfully constructed by private interests. While the private sector was responsible for a substantial part of early water development throughout the West, and while several other independent water storage enterprises were attempted in central Arizona, this project is the only local success. In a region that has been and continues to be dominated by federally sponsored water projects, the private development of the Agua Fria River remains an anomaly. (See Appendix 2.)[2]

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[1]The District or MWD, is located in parts of Townships 2, 3, and 4 North, Ranges 1 and 2 West. Annual precipitation for Phoenix during its territorial period was 7.60 inches. Although annual precipitation has remained relatively constant through the years, the Valley is becoming warmer each year due to the effects of urbanization. U.S. Congress, House, Irrigation Near Phoenix, Arizona, Doc. 342, 54th Cong., 2d Sess., 1897, 17-18, 22.

[2]Beginning in the late nineteenth century, several
(Footnote Continued)

In 1888, proponents of the Agua Fria project, principally speculative businessmen, not farmers, organized to develop the Agua Fria River. Their plan was to store and divert the river's annual flow through the construction of a permanent storage reservoir, diversion dam, and canal. The development's objective was to irrigate a large tract of vacant public land, over 100,000 acres. (See photo AZ-11-7.) Since other privately financed irrigation companies were diverting water in the Salt River Valley using the Salt River, constructing the Agua Fria project seemed plausible, although more ambitious and more costly since the project planned to store water as well as divert it. Construction of the project's masonry diversion dam and canal was initiated in 1892, but ceased three years later, before completion, because of financial limitations. Work on the project was not resumed until the 1920s, over thirty years later, essentially because the organizers' financial problems continually impeded its progress.[3]

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privately financed attempts to store water in the Salt River Valley failed. The Hudson Reservoir and Canal Company planned to store water on the Salt River. The Rio Verde Canal Company and its successors attempted to develop the Verde and New rivers. The Pennsylvania Irrigation Company planned to build a one hundred foot high dam on Cave Creek. Private attempts were also made to build a storage dam on the Gila River, south of Phoenix and on Queen Creek. All these efforts failed. Irrigation Near Phoenix, Arizona, 62-76. Central Arizona or the Phoenix metropolitan area is dominated by three federally developed water projects. The Salt River Project (SRP) consists of six storage dams and one diversion dam on the Salt and Verde rivers east of the Valley. The SRP was begun by the U.S. Bureau of Reclamation (formerly the U.S. Reclamation Service) under the Federal Reclamation Act of 1902. The San Carlos Irrigation Project (SCIP) was constructed by the U.S. Indian Irrigation Service, an office within the Bureau of Indian Affairs, and consists of Coolidge Dam on the Gila River and two diversion dams located downstream. The Central Arizona Project (CAP), presently under construction by the Bureau of Reclamation, is an interbasin transfer project which will bring Colorado River water to Phoenix and Tucson. Although several other irrigation organizations exist in the Valley, these three dominate the development of the region's surface and groundwater supply.

[3]The initial Agua Fria project proposed to develop 160,000 acres. This figure was overly optimistic and unrealistic. When the project was completed it serviced 40,000 acres.

As a privately funded enterprise, raising capital investment was always the Agua Fria developers' major concern. While most of the Valley's nineteenth-century irrigation works would become integrated into the federally financed Salt River reclamation project (SRP), the Agua Fria development remained separate from other Valley water developments. As an independent project, the proponents of the Agua Fria could not afford an expensive reclamation plan for its irrigation works. The U.S. Reclamation Service, which constructed the SRP, built a costly, material-intensive storage structure for the Project's Roosevelt Dam, because the Service enjoyed secure government financing in undertaking the project. Developers of the Agua Fria project were strictly limited by their financial assets. [4]

Because of economic restrictions, the leadership of the Agua Fria project was compelled to construct its irrigation plan at the least possible cost. They could only afford to build an inexpensive, material-conservative dam. Consequently, they selected a design that had already proven successful

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[4]Most of the private canal companies that had constructed irrigation works along the Salt River were purchased by the Reclamation Service when it constructed and operated the Salt River Project from 1903 to 1917. The construction of the Salt River Project, principally the construction of Roosevelt Dam and Granite Reef Dam, a diversion work, cost approximately three times the original estimate. The Roosevelt Dam power canal, which was built to provide the dam's contractor with hydropower generation, is a good example of the Salt River Project's cost overruns. The canal was originally estimated to cost $91,000, but when completed the cost had risen to $1.2 million. David M. Introcaso, "The Roosevelt Power Canal and Diversion Dam," 1984, National Park Service HAER Report, AZ-4, copy available at the Salt River Project Research Archives, Tempe, Arizona. For a history on the Salt River Project, see Karen L. Smith, The Magnificent Experiment, Building the Salt River Reclamation Project, 1890-1917, (Tucson: The University of Arizona Press, 1986), and Earl Zarbin, Roosevelt Dam, A History to 1911, (Phoenix, Salt River Project, 1984). See Stanley Roland Davison, "The Leadership of the Reclamation Movement, 1875-1902" (Ph. D. dissertation, University of California, Berkeley, 1952) for an excellent discussion on the distinction between private irrigation and federally sponsored reclamation. See also Donald J. Pisani, "Reclamation and Social Engineering in the Progressive Era," Agricultural History 57 (January 1983): 46-63, and John T. Ganoe, "The Beginnings of Irrigation in the United States," Mississippi Valley Historical Review 25 (June 1938): 59-78.

for other private irrigators in the West. The technology they chose for their storage dam, when work prepared to resume in the 1920s, was the multiple arch design. This design, used successfully in the United States since 1908, permitted the construction of a large storage reservoir within the financial limits of the project supporters. [5]

The financial advantages provided by the multiple arch design were substantial. Beyond other engineering attributes, the design was cheaper because it used less concrete. Through the sophisticated use of thin arched barrels supported by hollow buttresses, a multiple arch dam could impound a large reservoir of water at a savings of approximately thirty to forty percent over more traditionally designed dams. This advantage was too attractive to be ignored by the Agua Fria developers. [6]

The use of the multiple arch design proved to be expedient for the Agua Fria developers. It also proved to be controversial. Because the design used so little material, if the dam's construction was not flawless, faults immediately would become scrutinized. When buttress cracks appeared during the construction of Pleasant Dam, the safety of the multiple arch dam became a professional and public concern. A controversy soon erupted surrounding the safety of the multiple arch design, which some engineers believed to be an ersatz design anyway. Debate over the cracks also

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[5]The first multiple arch dam constructed in the United States was Hume Lake Dam built in California in 1908. It was designed by John S. Eastwood. For a study of the multiple arch design, John S. Eastwood, and the contributions made by the design to western hydrologic technology, see Donald Conrad Jackson, "A History of Water in the American West: John S. Eastwood and The Ultimate Dam (1908-1924)" (Ph. D. dissertation, University of Pennsylvania, 1986).

[6]The percentage of savings in the use of the multiple arch varied, generally, twenty to forty percent could be expected. Edward Wegmann, The Design and Construction of Dams, 8th ed. (New York: John Wiley and Sons, 1927), 439. Part four of Wegmann's book concerns the multiple arch dam. The section was written by Fred A. Noetzli. Noetzli was a California based hydrologic engineer. Jackson, "A History of Water in the American West," 7. Beyond the savings in construction materials, the multiple arch also lowered freighting costs since fewer supplies would have to be conveyed. In remote regions, where many dams were constructed, freighting costs could become appreciable.

challenged the dam's long term stability which in turn threatened the financial success of the project.

When the Agua Fria project opened in the 1930s, the Valley's only independently constructed water storage project finally had succeeded. Its accomplishment was attained, however, only after over forty years of significant hardship. Although other obstructions, including federal land use restrictions and litigation, added to the project's delay, financing always defined the status of the project. The completion of the Agua Fria Project, therefore, primarily demonstrated the enormous difficulty in constructing a privately financed large scale water storage project. The Agua Fria development also showed again how the use of multiple arch technology met the demands of private irrigation developers which enabled them to succeed within the institutional limitations of their organization. Finally, the post-construction controversy concerning Waddell Dam's stability highlights the role judgment plays in the engineering design of water resource projects.

Settlement in central Arizona was typical of many pioneer movements throughout the West. According to popular account, wild grass was cropped for hay from the Salt River bed to supply a military garrison and mines located north of Phoenix beginning in 1866. Because of the steady and rising demand for farm products by soldiers, miners, stockmen, and other settlers in the region, the Salt River's water supply was used to produce crops needed to feed a varying and growing population. Clearly, the Valley's mild climate, which provided for a year-long growing season, and a healthful environment prompted many people to settle in the Phoenix area. This growth trend inspired many developers, including Beardsley, to believe a large agricultural project could be profitable.[7]

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[7]In 1866, John Y. T. Smith harvested wild hay along the Salt River bottom and sold it to Fort McDowell, northeast of the Salt River Valley and to mines located northwest of the Valley, near Wickenburg. Smith was employed by the Army before contracting to supply hay. Jack Swilling had previously been involved in several activities in the territory including mineral prospecting. Actually, soldiers at Fort McDowell (established in 1865) constructed their own canal from the Verde River in 1866 to supply their camp with irrigation water. Swilling, along with others, formed the Swilling Company in 1867 and constructed the Swilling Ditch on the north side of the Salt River in 1868. Edgar Albert Hornig, "Reclamation of Arizona's Arid Lands" (M.A. thesis, University of Oklahoma, 1942), 11-33. For brief biographies
(Footnote Continued)

From the 1860s through the turn of the century, the Salt River Valley grew rapidly as an agricultural center. The twelfth census of the United States showed that in 1899 there were roughly 110,000 acres under cultivation in the Valley. Its various canal systems, which extended to over 250 miles by the end of the century, were providing water to both sides of the Salt River. Irrigated acreage produced a variety of crops valued at $2.25 million annually. The private capital invested in constructing the Valley canals was estimated at nearly $4.5 million. The population in the Valley had also risen dramatically from a scant few in the 1860s to approximately 20,000 residents by the end of the nineteenth century. Clearly, with the Valley growing steadily, Beardsley felt that a large agricultural project in the west Valley assuredly would be profitable.[8]

As settlement along the Salt River progressed, early development along the Agua Fria also advanced. The discovery of mineral wealth in the early 1860s quickly brought prospectors into the Agua Fria watershed in the Bradshaw Mountains in Yavapai County. Large amounts of gold, silver, copper, lead, zinc and other minerals were found throughout the region's rocky ledges. Because of the necessity for water in the mines' sluicing and hydraulic operations, the Agua Fria and Hassayampa rivers' watersheds supplied numerous mining districts including the Peck,

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on Smith and Swilling see, The Taming of the Salt, (Phoenix: Salt River Project, 1979), 11-19.

[8]U.S., Department of the Interior, Reclamation Service, First Annual Report of the United States Reclamation Service, 1902, (Washington: Government Printing Office, 1903), 78-79. Although the census gives an absolute amount of acreage under cultivation, it was difficult, if not impossible, to record a precise number. Acreage tended to be exaggerated by farmers and irrigation companies in order for them to protect their water right claims. See Davis' statement in Irrigation Near Phoenix at pages 53 through 55 concerning estimating the amount of acres under cultivation. Hornig, "Reclamation of Arizona's Arid Lands," 18-19. The rapid development of irrigated acres in the Salt River Valley was reflected in the greater West. In 1890, the first census to report irrigated acres in the western seventeen states listed 3,630,000 acres under cultivation. By 1900 that figure more than doubled to 7,527,000 acres. Golze, Reclamation in the United States, 12-13. For a general discussion on early economic activity in the Salt River Valley, see Geoffrey P. Mawn, "Phoenix, Arizona, Central City of the Southwest, 1870-1920," (Ph.D. dissertation, Arizona State University, 1979), 170-211.

Walker, Big Bug, Weaver, Lynx, Castle Creek, and Cherry Creek districts.[9]

Probably one of the most extensively developed mining enterprises along the Agua Fria watershed was on Humbug Creek. The Humbug Creek Placer Mining Company, a British enterprise, constructed a thirty-five foot high masonry dam and three-mile canal complete with three tunnels and a river crossing siphon along Humbug in 1890-1891. Water diverted by the dam and conveyed downstream through the canal was used at the company's hydraulic operation. By spraying a steady stream of pressurized water at the creek's high gravel embankments, the company hoped to expose ample deposits of gold. Although the mining company achieved some initial success, its operation did not last because it could neither maintain an adequate water supply nor produce a sufficient amount of bullion.[10]

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[9]Gold was discovered northwest of the Salt River Valley in the Prescott area in 1863 and in the Wickenburg area in 1864. See, Marshall Trimble, Arizona, A Panoramic History of a Frontier State, (New York, Doubleday and Company, 1977), 203-225; Patrick Hamilton, The Resources of Arizona, (San Francisco, A. L. Bancroft and Company, 1884), 143-180; Patrick Henderson, "The Public Domain in Arizona: 1863-1891" (Ph.D. dissertation, University of New Mexico, 1965), 17-28; Bil Gilbert, Westering Man, The Life of Joseph Walker, (Norman, University of Oklahoma Press, 1983), 267-277. Robert Spude and Stanley Paher, Central Arizona Ghost Towns, (Nevada Publications, Las Vegas, 1978), 42-48. A Reprint of the History of Arizona Territory, 1884, (Flagstaff, Northland Press, 1964), 249-250; Bert M. Fireman, An Historical Survey of Lake Pleasant Regional Park, Maricopa County, Arizona, (Phoenix, Maricopa County Park Service, 1963), 66-72; and generally Otis Young, Western Mining, (Norman, University of Oklahoma Press, 1970).

[10]According to the Arizona Weekly Journal Miner, the Humbug Company was not the first to use hydraulic technology to extract mineral wealth. Three other hydraulic mines had been in operation in Yavapai County prior to the Humbug development. "Humbug Creek Placers," Arizona Weekly Journal Miner, March 25, 1891; The Arizona Republican, March 17, 1891. The masonry dam used native stone and hydraulic lime burned at the site. At the center of the dam, at its base, the dam had a sluice gate six feet in height. The dam has a ninety-five foot crest length. Referred to as the Chinese Dam, the structure was probably built by Asian laborers previously employed by railroad companies working in the

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Mining activity in Yavapai County eventually brought the railroad into the area. In 1892, Frank M. Murphy and his business partner, "Diamond Joe" Reynolds, began the construction of the Santa Fe, Prescott and Phoenix Railway to freight ore extracted from their Congress Mine and generally to open up the mining country. The railway began at Ash Fork, north of Prescott. Three years later the line had been built nearly two hundred miles from Ash Fork, through Prescott and Wickenburg, into Phoenix. Commonly known as the Peavine, because of its twisted route, the railway connected Prescott with both the northern and southern transcontinental rail lines that passed through Arizona.[11]

Beyond his mining and railroad activities in Yavapai County, Murphy also developed Castle Hot Springs which he purchased in 1898. Located approximately twenty miles west of the Agua Fria River, the springs were discovered by U. S. Army Colonel Charles Craig while he stalked a band of Apaches in 1867. The hot springs soon became widely known for their

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territory. Four construction camps are associated with Humbug's construction activities. Mining resumed along Humbug Creek under the Humbug Gold Mines, Inc. from 1934 through 1937. The dam was regrouted in the early 1950s. With the exception of the sluicing gate, the dam remains intact. Interview with A. E. Rogge and Everett Bassett, Dames and Moore, Phoenix, Arizona, July 23, 1987. See also map titled, "Placer Lands of the Arizona Consolidated Development Company in Castle Creek and Frog Tanks Mining Districts," nd, Maricopa County Municipal Water Conservation District Number One Collection (hereafter MWD), Mining Development File, Salt River Project Research Archives, Tempe, Arizona. (All MWD files are located at the Salt River Project Research Archives.)

[11]Murphy sold the Congress Mine to Reynolds in 1895. Reynolds died shortly thereafter. Murphy would later go on to build several more railroads throughout Yavapai County. James H. McClintock, Arizona, (Chicago, S. J. Clark Publishing, 1906), 293-294; James Marshall, Santa Fe, The Railroad that Built an Empire, (New York, Random House, 1945), 265-267; Henry P. Walker and Don Bufkin, Historical Atlas of Arizona, (Norman, University of Oklahoma Press, 1979), 46-47; Trimble, Arizona, A Panoramic History of a Frontier State, 133-134; Interview with Richard E. Lynch, Arizona Historical Foundation, Hayden Library, Arizona State University, Tempe, Arizona, July 23, 1987.

purported medicinal benefits. Under Murphy's ownership the springs were developed into a major commercial resort.[12]

Early development in Yavapai County also saw the establishment of commercial stockraising. To meet the demands made by miners, cattle raising became profitable despite the risk of conflict with the native Apache. Though well north of the proposed Agua Fria project, cattle and sheep ranching became noteworthy in the 1880s through the efforts of William Kirkland, William Wingfield, and others. Ranches were established throughout the county particularly in the Verde River Valley. Cattle were sold to the mines and to the federal government to supply military posts and Indian reservations.[13]

The Salt River Valley initially developed as an agricultural community to support the needs of the military and miners. But as farming extended along the banks of the Salt River, the community evolved and soon became self-sustaining. Circumstances were different along the Agua Fria. The river was used only to exploit the mineral wealth located north of the Salt River Valley in the river's watershed in Yavapai County. Other land uses along the Agua Fria, principally food production, did develop, but were always attendant upon mining, responding to the demands required in supporting that activity. Farming in the Agua Fria watershed did not become independent as it did along the Salt River.

As mining began to exhaust the watershed's mineral wealth in the 1880s, the Agua Fria's resources became sought for other purposes. Envisioning development of the west side of the Salt River Valley, Phoenix promoters began to see the Agua Fria as a source to expand their irrigation plans for the

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[12]"Apaches and the Magic Water, Historical Sketch of the Discovery of Castle Hot Springs, Reminiscences of a Pioneer," Arizona Magazine, March 1914; Margaret Dudley Thomas, "Castle Hot Springs, Arizona Highways 50 (March 1974): 5-6. Murphy's brother, two-term territorial governor and congressional delegate, Nathan Oakes Murphy, resided at Castle Hot Springs through the winter. Over the years the resort has been visited by many notable individuals including Theodore Roosevelt, the Rockefellers, the Vanderbilts, and John F. Kennedy among others. In the winter of 1976 the resort was destroyed by fire. See, "Fire Destroys Famed Castle Springs Hotel," The Phoenix Gazette, December 10, 1976, 1, A24.

[13]Odie B. Faulk, Arizona, A Short History (Norman, University of Oklahoma Press, 1970), 157-164; Trimble, Arizona, A Panoramic History of a Frontier State, 248-253.

Salt River Valley. Providing a water supply for increasing irrigation needs became the river's new purpose.

Chapter II, The Beginning of the Agua Fria Project, 1888 to 1897

Despite the use of the Agua Fria River by mining and other interests for several decades, the first substantive and long term plan to develop the river's water supply was not initiated until the late 1880s. In 1888 Phoenix developers organized the Agua Fria Water and Land Company to construct several reservoir dams and canals to store and divert the entire flow of the Agua Fria River for agricultural development in Salt River Valley.[14]

By the spring of 1892, the company had ambitiously located five storage dam sites on the Agua Fria River and surveyed two canal lines on both shores. The first dam site was identified at the Frog Tanks stage stop. In June 1890 a second site was found about 1.25 miles downstream. The same month a third site was located four miles above Frog Tanks, at the confluence of Castle Creek and the Agua Fria. In September 1891, two additional sites were located. The first was approximately two miles above the Castle Creek site and the second about 3.5 miles further upstream. The Water and Land Company also surveyed possible canal lines and collected stream flow data. The company surveyed two canal lines to convey stored water to irrigable acreage downstream. Both canals were planned to begin on the east side of the river. Line A would parallel the river and extend south for approximately eleven miles. Line B would parallel the east side of the river for four miles before branching. One line would cross the river and continue southwesterly for an additional eighteen miles while the other would proceed southeasterly for twelve miles to a point near Cave Creek.[15]

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[14]The Agua Fria Water and Land Company was incorporated on November 10, 1888 by James D. Monihon, William A. Hancock, John P. Orme, Lindley Orme and Robert B. Todd. The general nature of the company was to acquire dams and canals by location, construction, erection, purchase or otherwise. The company was also organized to engage in general farming, merchandising, real estate and banking in the Arizona Territory. The amount of capital stock was fixed at $3,000,000 or 30,000 shares in $100 denominations. "Articles of Incorporation of the Agua Fria Water and Land Company," MWD, Agua Fria Water and Land Company File.

[15]The Frog Tanks stage stop was approximately thirty five miles northwest of Phoenix. It was located on the wagon route from Phoenix to the Castle Hot Springs resort. Frog Tanks also served as a distribution center for

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With its various examinations completed and water claims legally posted along the river, the Water and Land Company prepared to begin construction. The company contracted for the work in March 1892. To do the job, the company hired the Agua Fria Construction Company, a firm organized by George Beardsley, a recent arrival to the Valley from Hamilton, Ohio. While travelling through Phoenix in the early 1890s, Beardsley, an engineer, learned of the Agua Fria project and became convinced of its viability. With financial help from fellow Ohioans, he formed the construction company for the sole purpose of developing the Agua Fria project. George Beardsley also won the support of his brother William, a slate board merchant from Hamilton. William readily joined his brother in Arizona, possibly because of the recent death of his wife. Together they[16] united to develop the Water and Land Company's plan.

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equipment used in conjunction with mining developments along Humbug Creek and other tributaries of the Agua Fria. The stage stop's location was the northwest quarter section of Section 28, Township 6 North, Range 1 East. Frog Tanks apparently acquired its unusual name from a naturally formed pool that was inhabited by frogs. The site was originally occupied by Alex Williams. Williams' estate was obtained by Eugene St. Claire and William B. Pratt on an unknown date. Through the influence of Nathan Oakes Murphy, a post office was established at Frog Tanks from May 1890 through August 1896. It was named after Pratt, who worked a mining operation in the area and became the office's first postmaster. Will C. Barnes', Arizona Place Names, Revised and Enlarged by Byrd H. Granger, (Tucson, University of Arizona Press, 1985) 181, 192; Memo, "Early History of the Carl Pleasant Dam," nd., MWD, 1890s File; Memo, "Original Rights and Locations," nd., MWD, Agua Fria Water and Land Company File.

[16]George Beardsley was the son of Henry Beardsley and Abbie Beardsley, Henry's third and last wife. (See photo AZ-11-1.) Henry Beardsley, also from Hamilton, Ohio, was a manufacturer and dealer in clothing and straw goods. William Henry Beardsley was the son of Henry and Ida Beardsley, Henry's second wife. William Beardsley joined his brother in Arizona, leaving behind his young son, Robert Oglesby, who was born in 1889. Robert was raised by Beardsley's relatives and joined his father in Arizona after graduation from college. William Beardsley, beyond holding the position as general manager of the Agua Fria Construction Company, also became a board member of the Agua Fria Water and Land Company. The Agua Fria Construction Company was incorporated in Kentucky by H. L. Morey, Collins
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The Water and Land Company's contract with the Construction Company was limited to the construction of a masonry reservoir dam at Frog Tanks, a rock-filled masonry service or diversion dam 1.25 miles downstream, and canal line B. Work was to be completed no later than the end of 1895.

The Agua Fria Water and Land Company and the Agua Fria Construction Company proceeded with the project despite encountering difficulties in receiving necessary approval from the Department of the Interior for their plan. To win authorization of the development, federal law required the Water and Land Company to submit for approval information showing proof of its organization and maps and plats showing the reservoir sites. Upon completion of its river observations, examinations, and surveys in the spring of 1892, the company forwarded its maps to the local General Land Office for transmission to Washington for approval by the Secretary of Interior. The company's maps were rejected the following month because the lands that the reservoir basin would inundate had not been surveyed.[17]

The Water and Land Company was not concerned with the government's decision since it had contracted with the Agua Fria Construction Company three months prior to the submission of its drawings. The incorporators may have expected an unfavorable response from Washington since the city of Phoenix had failed previously to win Congressional

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Ford, William Roushein, P. H. Kumler and George Beardsley. Officers for the company were: H. L. Morey, president; Charles B. Oglesby, treasurer (and presumably William Beardsley's father-in-law); H. E. Twitchell, secretary; and R. R. Coleman, chief engineer and superintendent. Coleman had previously worked on the construction of the Santa Fe, Prescott and Phoenix Railway. Interview with William M. Beardsley, Robert O. Beardsley's son, December 10, 1986; Memo, "Early History of Carl Pleasant Dam," nd, MWD, 1890s File; "Contract and Specifications For Building Masonry and Rock-Fill Dams and Canals . . .", March 18, 1892, MWD, Contracts, Agreements and Specifications File.

[17]The Water and Land Company was required to comply with the March 3, 1891 modification (26 Stat. 1095) of the Desert Land Law of 1877 (19 Stat. 377). It is unclear exactly why the General Land Office returned the company's maps. The Desert Land Act required a specific description of the land if surveyed, but if unsurveyed, made exceptions by stating that unsurveyed lands should be described "as nearly as possible without a survey." The company's project area was finally surveyed and mapped by the General Land Office from 1894 to 1896. "Original Rights and Locations."

support in developing its water supply. Earlier, in 1889, Phoenix boosters unsuccessfully petitioned a Senate Select Committee on Irrigation and Reclamation of Arid Lands, meeting in Phoenix, to support an irrigation development plan by either lending the territory money or granting it permission to issue bonds to fund the construction of a storage reservoir. Unsuccessful in winning federal support, local private developers organized and planned their developments independent of federal support or sanctions. Developers in the territory, especially miners, were more concerned with making their efforts a success than in satisfying abstract and distant federal requirements. The Water and Land Company probably believed in their preemptive right to forward their project, thereby giving them, in their view, de facto authority.[18]

The plans for the storage dam at Frog Tanks called for a masonry block and hydraulic lime mortar structure of undetermined height. The dam was planned to include a "suitable spill-way" and a service pipe through the masonry face to release water for irrigation. The diversion dam, which was initially known as the Beardsley Dam, was planned as a rock-filled masonry work, also of undetermined height. Rock for both dams would be quarried near the dams while the hydraulic mortar would be burned near the river crossing of the Santa Fe Railroad, approximately seventeen miles downstream from the construction site. Canal line B was selected to travel the entire twenty-two miles without its southeasterly branch.[19]

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[18]Mawn, Geoffrey, P., "Phoenix, Arizona: Central City of the Southwest, 1870-1920" (Ph.D. dissertation, Arizona State University, 1979), 219-223.

[19]Specifications for both dams under the March 18, 1892 contract were vague. The method of conducting the work, as defined in the contract, was left to the "discretion of the contractor." Although the diversion dam was originally known as the Beardsley Dam it later became known as the Dyer Diversion Dam. The top length of the diversion dam was 650 feet. The width or thickness at bedrock was forty to sixty feet. The dam was 35 feet in width at the surface of the river bed and eight feet at the crest. The upstream end had a perpendicular face while the downstream side had a batter of three feet to five feet in height. No construction drawings remain concerning the diversion dam, probably few were made. Some cement was used in the construction. Rock used in the masonry was a sand conglomerate. "Original Rights and Locations"; "Contract and Specifications For Building Masonry and Rock-Fill Dams and Canals . . .,";
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To make the project a success, the Beardsleys needed to convince investors to settle in the undeveloped service area and to subscribe to stock issued by the construction company to finance the project. The Water and Land Company, under William Beardsley as president, prepared a brochure in 1895 to promote the project nationally. The pamphlet predicted that, when completed, the system would consist of a diversion dam, two reservoir dams, fifty miles of main canal, and two hundred miles of laterals. The pamphlet promised that the diversion dam and canal would be completed by December 1895 with the construction of the reservoir dam at Frog Tanks to start immediately thereafter. Acquiring a forty acre plot under the project, the brochure advertised, would only cost the farmer $79. The pamphlet concluded by stating that "there is no other irrigation proposition in Arizona so promising at the present time as the Agua Fria Water and Land Company's reservoir and canal system." At least "twenty thousand acres," the pamphlet claimed, "will be put in crops the coming winter and spring." To finance the construction of the project, Beardsley's construction company issued six hundred coupon bonds in June 1895 in $1,000 denominations. The bonds were to return seven percent per annum and were redeemable ten years later through an investment house in Cincinnati.[20]

Because of the severe financial depression that engulfed the nation in the early 1890s, the Beardsleys experienced difficulty in obtaining sufficient capital. Consequently, all of 1892, 1893, and most of 1894 was spent in seeking financing for the project and preparing the site for construction. The Beardsleys were able to initiate several preconstruction activities, however, having obtained a

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Irrigation Near Phoenix, Arizona, 69-71; James Dix Schuyler, "Report on the Water Supply of the Agua Fria River, and the Storage Reservoir Project of the Agua Fria Water and Land Company For Irrigation in the Gila River Valley, Arizona," September 29, 1903, 25, Arizona Historical Collection, Hayden Library, Arizona State University, Tempe, Arizona.

[20]For forty acres, the settler would pay $25 towards his entry fee and $54 for a water privilege. The brochure reprinted two photographs showing the diversion dam's construction progress and a drawing depicting the dam as it would look when completed. The brochure was titled, "Map of Agua Fria Valley and the Western Portion of the Salt River Valley, Showing the System of Reservoirs and Canals of the Agua Fria Water and Land Company and The Land to Be Irrigated Thereby, 160,000 Acres of New Land To Be Reclaimed in Maricopa County, Arizona Territory," nd. MWD, District Organization File; "Original Rights and Location."

limited number of workers and equipment. They cleared the diversion dam and reservoir dam sites, developed the rock quarry, constructed a work camp named Camp Dyer on the east side of the diversion dam site, and furnished approximately two thousand cubic feet of cut stone. In late 1894, Beardsley was able finally to begin work at the diversion dam and canal.[21]

The construction at the diversion dam began simultaneously at both banks with the excavation to bedrock. Foundation work and actual construction was conducted essentially in two distinct sections because of an island or rock abutment which divided the dam site and ultimately served as its mid-section. Exposing the foundation was completed by using explosive powder and earth scrapers drawn by teams of mules or horses. Because the geological characteristics of the foundation were unknown, exposing the dam's bedrock base required more effort than originally anticipated. Bedrock excavation required the removal of 36,000 cubic feet of earth.[22]

With the foundation cleared, workers began setting stone. Quarried rock was set in place using a cable conveyor which spanned the length of the dam. During the construction, the contractor diverted the river's flow through two sluice openings that were left as the dam rose above the stream bed. As the year 1894 ended, the dam began to rise above the river bottom.[23]

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[21]Camp Dyer and the diversion dam were named after E. J. Dyer who worked for Beardsley as a surveyor. Edgar J. Dyer, nicknamed Czar, came to Phoenix after serving in the Navy. Dyer was known principally for his map making work. Many of his drawings, because of their aerial perspective, were referred to as "bird's eye views." Dyer also served as acting mayor of Phoenix from January to May 1899 and on the city council. Dyer died in March 1903. "Has Anyone Seen a Photograph of Frank Moss," The Phoenix Gazette, December 12, 1980; "Original Rights and Locations."

[22]The west side of the dam was shorter being approximately seventy feet in length. The depth to bedrock at its deepest point was thirteen feet below the channel on the east side of the diversion dam and forty feet below the river channel on the west side. Storage capacity behind the diversion dam was approximately nine hundred acre feet. Schuyler, "Report on the Water Supply of the Agua Fria River . . ." 23-25; "Original Rights and Locations."

[23]"Original Rights and Locations"; "Contract and
(Footnote Continued)

In 1895, William Beardsley continued the work on the diversion dam and also began to excavate the canal. During the year the dam's east wing was brought to thirty feet above the stream bed for a distance of 450 feet. In the west channel, Beardsley had the masonry brought five feet above the river bottom. Work on the canal began on the first four miles from the canal's heading at the diversion dam on the east side of the Agua Fria to a point where the canal was planned to cross the river through a seven-hundred foot flume. The canal work was difficult and progressed very slowly. At its heading, the canal had to be cut through solid rock and then traverse rocky and broken terrain. Work was performed by the Phoenix contractors Toohey and George.[24]

In the fall of 1895, Beardsley had brought the top of the diversion dam within four feet of the bed of the canal heading. The west end of the dam had risen an additional twenty two feet above the river. In one year the Beardsleys set eighteen thousand cubic yards of masonry and excavated over 100,000 cubic yards of earth from the canal line. The difficulty in digging the canal and erecting the diversion dam, particularly the effort required to uncover the foundation, required Beardsley to spend more than $60,000 to perform the work. This was much more money than either he or the Water and Land Company had anticipated. In October, hopes that the work would be completed died suddenly. Heavy rains brought a flood down the river that carried out a portion of the west side of the dam. The damages resulting from the storm, combined with the excessive construction costs, caused Beardsley to shut down his operations. (See photos AZ-11-2 through AZ-11-5.) Stubbornly believing that the delay would only be temporary, Beardsley hired a watchman, Robert "Jerry" Jones, to oversee the property until he could resume work.[25] (See photo AZ-11-6.)

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[24]The canal was alternately called the Agua Fria Canal, the St. John's Ditch or the Orange Belt Canal. Phoenix Enterprise, November 12, 1902, 8; Arizona Gazette, September 8, 1895, 1. The canal was planned to continue from the flume and extend to the southwest and cross the Santa Fe, Prescott and Phoenix Railroad about eight miles west from the Agua Fria River. The canal was planned to be eighteen feet wide on the bottom, forty-two feet wide on top and unlined. Carrying capacity was estimated at four hundred cubic feet per second. Irrigation Near Phoenix, Arizona, 69-71.

[25]Masonry laid in the dam amounted to a total of 18,700 cubic yards, nine thousand yards in the foundation and

(Footnote Continued)

In 1896, William Beardsley, now working without the help of his brother George who had died the year before, tried to secure additional funds to complete construction. This proved an impossible task since it was the third year of a national economic depression. Without more financing, Beardsley could not continue work. Even worse, he could not pay his subcontractors for equipment and materials that they had already supplied. Beardsley now faced legal complaints filed by more than ten of his subcontractors for over $24,000 in delinquent bills. Since he could not raise any more money, the Maricopa County Court rendered a decision in favor of Beardsley's subcontractors. To pay his debts, the court set a date to auction the assets of both the Agua Fria Water and Land Company and the Agua Fria Construction Company. Beardsley's construction company and the Water and Land Company were officially bankrupt.[26]

(Footnote Continued)
remainder above the stream bed. The cost of the work was reported to be $66,298.61 or an average of $3.64 per cubic yard of masonry. The flood of October 2, 1895 carried water to a height of eight feet over the dam. The causes for the dam's partial failure were explained by Arthur P. Davis, hydrologist for the U.S. Geological Survey, and author of the Congressional report Irrigation Near Phoenix, Arizona (already cited). Davis wrote, "The carried away portion showed horizontal joints finished and plastered as smooth as though intended for a floor, apparently diminishing the bond with the next course above." In an unsigned letter written to R. R. Coleman, Agua Fria Construction Company chief engineer and superintendent, it was stated, "WHB away. Wired back to `shut down.' Developed [sic] [has] no money left." Letter, nd, MWD, 1890s File; "Original Rights and Locations"; Irrigation Near Phoenix, Arizona, 69-70; Schuyler, "Report on the Water Supply of the Agua Fria River," 23-25.

[26]Upon his death, George Beardsley's estate was valued at $2,900 including 115 shares in capital stock in the Agua Fria Construction Company. George Beardsley estate, Probate Court, Maricopa County, Case 314, May 3, 1895. The following companies filed complaints against Beardsley for remittance: the California Portland Cement Company for $2709.10; Goldman and Co. for $935.93; W. K. James for $904.55; John C. Kellum for $1984.65; J. D. Martin and A. R. Jenkins for $2210.02; and L. W. Blinn Lumber Co. for $638.40. Nine other claims were filed against Beardsley but for unknown reasons were not pursued. Copies of the litigation in MWD, 1910s File. See also P. H. Hayes to W. H. Beardsley, July 13, 1908, MWD, 1910s File; "Statement to Accompany the Application of the Agua Fria Water and Land
(Footnote Continued)

In March 1897, Maricopa County sheriff, Lindley Orme, conducted the auction. Ironically, Orme was one of the incorporators of the Agua Fria Water and Land Company. The assets of both companies were awarded to the California Portland Cement Company, the Blinn Lumber Company and William Christy, assigned as trustee for several of the plaintiffs, for the sum total of $11,317. Sold to the plaintiffs was the Frog Tanks dam site, the diversion dam and the completed portions the canal.[27]

Five years after signing the contract to construct the Agua Fria project, the Beardsleys' efforts had gone unrewarded. the diversion dam sat useless in the stream bed. The flood of October 1895 had damaged its western face, the river diversion sluices remained open, and the dam's crest was still below the canal heading. The canal was little more than a broken series of excavations over four miles. Most serious of all, both companies' assets had been lost.

Compounding Beardsley's disappointment in the project's failure was Arthur Powell Davis' opinion concerning the necessity for the diversion dam. Davis, a hydrologist with the United States Geological Survey, wrote in an 1897 report on Salt River Valley irrigation that the construction of the diversion dam was unnecessary. After reviewing the Agua Fria project, Davis concluded,

> The plans of this irrigation project appear to be open to criticism for by continuing the canal 1.25 miles farther up the canyon it would have reached the lower reservoir dam site, . . . which would have served as a diversion dam [also], and the cost of the dam already constructed might thus have been saved. The construction of the canal through this distance would be expensive, as the country is rough, but it certainly would not approach in cost that of the diversion dam.[28]

The Agua Fria project could have ended during the auction held on the county courthouse steps. The companies' assets were lost and Beardsley did not recover them during a six month redemption period that followed the auction. After the redemption period expired in September 1897, however,

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[27]The auction was held for three days, March 10, 11, and 13, 1897. William Christy was a prominent banker in Phoenix and a leading political figure in the territory.

[28]Irrigation Near Phoenix, Arizona, 71.

the companies' property was transferred to Charles E. Heiser. Heiser, representing Beardsley's Ohio stockholders, acquired everything immediately after the redemption period had expired for the auction price. One month later, Heiser made a quit claim deed to Beardsley for the Frog Tanks dam site, the diversion dam, and the canal. In essence Beardsley regained everything he had lost.[29]

Evidently, Beardsley was able to acquire new funding during the redemption period. Although he was unable to pay his subcontractors, stave off the auction, or have an agent successfully bid for the companies' assets, Beardsley obtained additional investment from his Ohio stockholders probably because they realized they would forfeit their initial investment if they did not invest further. Beardsley must have convinced Heiser to acquire the property from the plaintiffs, and then transfer it back to him.[30]

Despite suffering two years of litigation which led to bankruptcy, Beardsley miraculously managed to regain the assets of the Agua Fria Water and Land Company and the Agua Fria Construction Company. With the national economy recovering from the depression and renewed support from his Ohio backers, Beardsley could be optimistic about recommencing construction in 1897. The diversion dam remained unfinished, but the majority of the masonry work had been completed. Although most of the canal was yet to be excavated, the most difficult work of cutting thru solid rock for the headgates was principally completed. The watchman remained at the site throughout the layoff period, so the construction facilities were intact and ready for

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[29]One can speculate why the plaintiffs bid for the Agua Fria companies' assets. By bidding the amount that they were owed, the subcontractors most likely wanted to insure that their costs would be recovered. After the auction, Beardsley potentially had a six month period, called a redemption period, when he could recover his losses. Heiser recovered Beardsley's assets for $11,317, the same amount for which he lost them. The quit claim deed was executed on October 26, 1897.

[30]Heiser quit claimed the companies' assets to Beardsley for the consideration of one dollar, probably, but not necessarily, the actual amount of the transaction. The evidence suggests that Heiser was a resident of Ohio. His name does not appear in the Phoenix directory for the years 1895 through 1900 and the quit claim transaction was acknowledged by a Butler County, Ohio, notary public. Hamilton, Beardsley's home, is the county seat of Butler County.

reuse. All that Beardsley needed to begin again was to maintain the support of his Ohio investors and hire laborers and reacquire supplies.[31]

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[31]Robert "Jerry" Jones remained as Beardsley's watchman until 1916. At that time he was replaced.

Chapter III, Mired in Setbacks, The Agua Fria Project Is Delayed Twenty Years, 1898 to 1918

The Agua Fria Water and Land Company's irrigation plan was relatively simple. The company proposed to construct a series of storage dams and canals to provide water to irrigate vacant public lands. With a secured water supply, otherwise unproductive and valueless lands would be sought for their farming value by settlers. The cost of constructing the irrigation enterprise would then be profitably recovered through the sale of water rights and water rentals. The company's outline for success appeared certain.

Although heavily invested in the project's development already, Beardsley's Ohio associates grew increasingly skeptical. Because of the Water and Land Company's first failure, the prospects for the project's ultimate success no longer seemed assured. Confidence in the project sank further when sentiment grew that the average farmer would not be able to pay his water assessments when the project was completed. Many concluded that the Agua Fria development was untenable. During the period from 1897 to 1918, Beardsley strove to acquire refinancing to restart the project. Unfortunately, these economic difficulties became secondary when several additional setbacks and challenges threatened the project beginning in 1902. The day when the Agua Fria development would create "the garden spot of Arizona," was still many years distant.[32]

Because of the adverse financial opinion that began to surround the project, Beardsley was unable to raise the necessary capital to continue the project, even from his Ohio associates. For four years, beginning in 1898, no progress was made. No upgrades were made to either the diversion dam or the canal, nor was any activity undertaken at the Frog Tanks reservoir site. The only evidence to suggest that the project was still viable was the continued service of watchman Jones, who remained at Camp Dyer. For all practical purposes, the Agua Fria Construction Company

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[32]The uncertainty in paying water assessments probably stemmed from the difficulties farmers under the Salt River Project faced in meeting their repayment obligations. Since the Salt River Project, completed in 1911, cost considerably more to construct than was estimated, water assessments were considerably more than expected. This fear was probably projected onto the Agua Fria development. "Original Rights and Locations." Promoters of the project in the 1920s began to advertise lands for sale under the project's development as, "the garden spot of Arizona."

had ceased to exist. Beardsley probably did not return to Phoenix from Ohio after resecuring the company's assets from Charles Heiser. His single accomplishment during these years was superficial. Since the Agua Fria River was finally surveyed by the federal government, Secretary of the Interior Ethan Allen Hitchcock granted the Water and Land Company a right of way for its canal and storage dam at Frog Tanks.[33]

In July 1902, the Secretary's easements for the canal and the Frog Tanks reservoir became valueless. Under the newly authorized National Reclamation Act, Secretary Hitchcock ordered the withdrawal of public lands that could receive the benefits of the federal government's construction of storage reservoirs in the West. In the Arizona Territory, Hitchcock selected the Salt River Project as one of the nation's first federal reclamation projects. Ostensibly, the Secretary withdrew public lands to prevent land speculators from inflating real estate prices while the reclamation projects were being constructed. Included within Hitchcock's withdrawal for the Salt River Project were lands under Beardsley's Agua Fria project.[34]

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[33]There is a complete lack of documentation during this period concerning the activities of the Agua Fria Water and Land Company and the Agua Fria Construction Company. Jones remained at Camp Dyer not because he was Beardsley's employee, as he was never paid on a regular basis, but because he independently operated an inn at the site. A 1906 map identified a "Jerry's Place" at the Camp Dyer site. Neither Beardsley nor the Agua Fria Construction Company are listed in the Phoenix telephone directory for this period. The Secretary of the Interior granted an easement for the canal on February 7, 1898 and for the storage reservoir at Frog Tanks on April 2, 1901. An easement was not granted for the diversion dam at this time. Memo, General Land Office, August 30, 1915, MWD, Land Restoration File; Schuyler, "Report on the Water Supply of the Agua Fria River . . . ," 1.

[34]Lands in the Salt River Valley were withdrawn by the Secretary on July 17, 1902. William Beardsley to the Commissioner of the General Land Office, August 30, 1915, MWD, Land Restoration File. The Reclamation Act was signed into law by President Roosevelt in June 1902. Under the provisions of the Act, a portion of the funds deposited through the sale of public lands in each of the seventeen western states and territories were to be used to finance the construction of water storage facilities by the federal Reclamation Service (known as the Bureau of Reclamation

(Footnote Continued)

William Beardsley's problems now worsened. The project could not be constructed as planned given the Secretary's land withdrawals. As Beardsley stated, Hitchcock's order left the Agua Fria project with "no lands to irrigate." Six months after Hitchcock's order, Beardsley applied to have the withdrawal amended. In February 1903, the Salt River Valley Water Users' Association, the organization that would receive the benefits of the Salt River Project, defined its reservoir district boundary under its articles of incorporation. To his delight, Beardsley learned that the articles limited the Water Users' reservoir district boundary to lands up to, but not west of, the Agua Fria River. Beardsley's plan was to cultivate lands west of the river. With the Water Users' reservoir district defined, Beardsley reasonably hoped that the Secretary would amend the withdrawal. He immediately petitioned Hitchcock.[35]

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since 1924). Landholders receiving water under the developed projects would then have ten years, later extended, to repay the government for its construction work. The Salt River Project, the Service's first large scale construction project, was planned to serve agricultural lands in the Salt River Valley. The project was estimated to provide irrigation water to 250,000 acres. Concerning the selection of Arizona's first federal reclamation project, see Karen Smith, "The Campaign for Water in Central Arizona, 1890-1903," Arizona and the West 23 (Summer 1981): 127-148.

[35]The Secretary's withdrawal affected most of the Water and Land Company's service area. The Secretary withdrew lands from Townships 1, 2, 3 and 4 North, Range 1 and 2 West. The lands that the Salt River Valley Water Users' Association defined as their reservoir district boundary were east of the proposed Agua Fria service area lands. In section three of the Water Users' articles their boundary in this area was to include sections five and six, Township 3 North, Range 1 East to the left bank of the Agua Fria and then south along the left bank of the river to section 14, Township 1 North, Range 1 West. After the Water Users defined their district boundary, Beardsley credibly could ask how the Secretary could maintain the withdrawal of lands west of the Agua Fria. See Section 3 of the Salt River Valley Water Users' Association's Articles of Incorporation, reprinted in the U.S. Department of the Interior, Reclamation Service, Second Annual Report of U.S. Reclamation Service, 1902-1903, (Washington: Government Printing Office, 1904), 77; Beardsley to the General Land Office, August 30, 1915, MWD, Land Restoration File; Schuyler, "Report on the Water Storage Supply of the Agua Fria River . . . ," 22.

Upon receiving Beardsley's application, Hitchcock forwarded the matter to the newly created Reclamation Service under the direction of Frederick H. Newell. The Service was directed by Hitchcock to review the feasibility of the Agua Fria project and to forward its recommendations to him. Because of the Geological Survey, federal engineers were already familiar with the Salt River Valley's water supply. They had previously undertaken hydrologic studies in central Arizona, principally on the Salt and Gila rivers watersheds. However, federal engineers and hydrologists were preoccupied with preparing to construct the Salt River Project's Roosevelt Dam, its various appurtenant features, and three other reclamation projects in the West. Newell's priorities therefore centered exclusively around federal reclamation developments. Before he would make any recommendation to Hitchcock, Newell advised Beardsley that he retain a qualified engineer to perform a feasibility study on the Agua Fria project and forward the results to him for review.[36]

To perform the hydrologic feasibility study, Beardsley hired James Dix Schuyler. Schuyler was a highly reputed Los Angeles hydraulic engineer. He was a renowned author on dam design and former vice president and director of the American Society of Civil Engineers. He had worked on numerous large water projects, including the Panama Canal. Schuyler examined the Agua Fria project's dam sites and canal lines. He also evaluated stream flow and rainfall records and assessed the local conditions for irrigated agriculture. After inspecting the project with Beardsley and reviewing the stream flow data, Schuyler wrote a very thorough report in September 1903.[37]

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[36]Beyond the Salt River Project, Hitchcock also authorized the Milk River Project in Montana, the North Platte Project in Nebraska and Wyoming and the Newlands Project in Nevada. The Reclamation Service initially operated under the Interior Department's Geological Survey before becoming an independent agency within Interior. The federal government had previously issued several studies on water resources in central Arizona. Beardsley to the Commissioner of the General Land Office, March 30, 1915, MWD, Land Restoration File.

[37]James Dix Schuyler, Reservoirs for Irrigation, Water Power and Domestic Water Supply, (New York: John Wiley and Sons, 1901). For a biography on Schuyler, see "Schuyler, James D.," Transactions of the American Society of Civil Engineers 76 (1913): 2243-2245. Schuyler's papers are at the Water Resources Library at the University of California

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Schuyler was able to review stream flow records that had been taken between 1889 and 1895 by William Hancock, chief engineer for the Agua Fria Construction Company. Using Hancock's measurements, Schuyler concluded that the Agua Fria had an appreciable average annual runoff. He estimated it to have a fifty to one hundred percent greater yield per square mile than either the Salt or Verde rivers' watersheds. This was attributable to the watershed's topography which was mountainous and without large valleys or plateaus. Schuyler concluded that in the majority of years, eight out of ten, 140,000 acre feet of water could be developed. In drought years the minimum supply might be reduced to approximately 80,000 acre feet. These estimates excluded losses from seepage and evaporation.[38]

After examining the dam site at Frog Tanks, Schuyler found that a 130 foot high masonry dam "can assuredly be built with safety and certainty." Bedrock soundings indicated that the majority of the foundation was only eight to fourteen feet below the river bottom. "The foundations are all that could be desired," Schuyler wrote, "so far as I could determine by visual inspection." Masonry used in the construction would come from a quarry, already opened, one-quarter mile above the dam site. Adequate quantities of lime for burning cement were also found at the site.[39]

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at Berkeley. Schuyler visited the Agua Fria development in August 1903. His report was issued the following month.

[38]Schuyler estimated the Agua Fria watershed to be 1,560 square miles, the Salt River watershed above the Roosevelt Dam site to be 5,756 square miles and the Verde watershed to be 6,000 square miles. Apparently, watchman Robert Jones was not directed to take stream flow measurements. An acre foot of water is approximately 325,000 gallons. Schuyler, "Report on the Water Supply of the Agua Fria River," 2-13.

[39]Soundings along the foundation indicated the nearness of bedrock except for a fifty foot section where Schuyler estimated the foundation to be forty feet below stream bed. Schuyler recommended that diamond core drillings be taken to determine accurately the exact bedrock depth. The stone to be quarried for the storage dam was not obtained from the quarry opened for the diversion dam. Stone for the diversion dam was obtained downstream from that site. Schuyler estimated that the dam would require 160,322 cubic yards of rock, 38,000 barrels of cement and 90,000 barrels of hydraulic lime.

Upon inspection of the partially completed diversion dam, Schuyler found it to be of "superior quality," despite the flood damage. Unlike Davis, he did not question whether its construction was necessary to the development of the project. In order to bring the dam into service, Schuyler estimated that the crest would need to be raised only ten more feet which would require only two thousand more cubic feet of masonry. The added height to the dam, Schuyler recommended, should be accomplished using masonry laid in Portland cement and not hydraulic lime. This would prevent the masonry from sliding again, Schuyler believed, if it should be overtopped by flood during construction.[40]

After reviewing the profile of the canal, Schuyler recommended that a substantial water drop be developed after the canal crossed the Agua Fria using a wood stave pipe. With a potential fifty foot fall, Schuyler thought that a one hundred horse power hydropower generation plant could be built on the west side of the river to take advantage of the water's fall. This could pump sixty thousand acre feet of water for the irrigation of twenty thousand additional acres. Because of the superior purity of Agua Fria water and the drop in elevation to Phoenix, Schuyler also suggested the possibility that a thirty-two mile gravity pipeline could be constructed to carry water to Phoenix.[41]

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[40]In addition to the weaknesses inherent in horizontal joint construction, the west end of the dam failed because the masonry was set in hydraulic lime which was still green when flood waters washed over the crest. Since the diversion dam was constructed during an economic depression, Schuyler believed that its construction cost, which Beardsley thought high, was actually very economical. In 1903, Schuyler did not think the work could be replicated for less than an increase of fifty percent.

[41]The canal would cross the river in a 3,700 foot, 7.5 foot diameter wood stave pipe which would be carried across the river over a steel bridge. Schuyler estimated that a net head of forty two feet with a three hundred second foot flow could theoretically develop 1,400 horsepower. The water table, Schuyler estimated, at forty feet below the surface. With over one thousand horsepower available, twenty wells, each using fifty horsepower, would raise two hundred acre feet per day or 73,000 acre feet per annum if pumped without cessation. Schuyler reduced this estimated yield to sixty thousand acre feet per annum which he considered a more reasonable amount. Schuyler also recommended that the canal line, for a distance of four miles below the river crossing, be rerouted and carried

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Schuyler computed that more than 100,000 acre feet of water could be produced most years with the project's storage dam in place. With a duty of water of three acre feet, Schuyler concluded that 34,000 acres could be cultivated. The addition of pumped groundwater could increase cultivated acreage to nearly sixty thousand acres. In years of excessive rainfall, Schuyler determined that seventy thousand acres could be irrigated by combining both surface and groundwater.[42]

The cost of completing the diversion dam, the canal, and constructing the storage dam and power plant, was estimated at approximately $1.3 million. This investment would be marginal, Schuyler believed, considering the healthy return the developers would realize. Assuming title to the service area lands - a major assumption - and a secure water supply, previously valueless arid lands would sell for $60 to $100 per acre. If 50,000 acres were sold at only $40 per acre, for example, a forty to fifty percent return on investment would be attained. Surface and groundwater could be sold for $1 per acre foot, thereby yielding a constant annual revenue for the project. After operation and maintenance expenses were computed, Schuyler estimated that the project's net annual income would be $143,000. He suggested also that a greater return could be made if hydropower generation was included.[43]

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along the river to avoid broken ground. Schuyler estimated that an eighteen inch pipe line would be required to carry water to Phoenix. The fall or total head from the power plant to Phoenix was calculated at four hundred feet.

[42]The over 100,000 acre feet is the net water yield after subtracting evaporation in the reservoir and seepage losses through the canal. Schuyler computed evaporation to be ten thousand acre feet annually and seepage losses to be approximately twenty percent of the canal flow or 26,000 acre feet.

[43]The estimated cost for completing the diversion dam was $50,978. Completing the canal was estimated at $132,462. Constructing the storage dam was estimated at $1,003,938. The power plant was estimated to cost $90,000. Lowering the storage dam ten feet would save $171,000 but would reduce the dam's storage capacity to ninety thousand acre feet. Additional monies could be saved by eliminating the canal bridge crossing and replacing it with a steel reinforced concrete pressure pipe under the river bed. Another alternative to save money would be to use reinforced concrete in portions of the storage dam instead of masonry
(Footnote Continued)

With Schuyler's complete endorsement, Beardsley immediately sent his report to the Reclamation Service. Despite its healthy assessment of the project, Schuyler's report did little to convince Newell and the Reclamation Service of the project's feasibility. Apparently, Newell had already developed an unfavorable opinion towards the development. Prior to Schuyler's undertaking the Agua Fria report, Newell wrote Schuyler telling him that he had been contacted by the Agua Fria developers regarding the feasibility of their water storage plans. The information that Newell received from the Agua Fria promoters led him to admit to Schuyler that the water storage plan constituted a "wholly chimerical project." Newell cautioned Schuyler that he should anticipate contact from the project developers asking that he make an assessment of their project. He also encouraged Schuyler to make a very complete analysis of the plan, suggesting that he include a table showing "the amount of water which would be in the reservoir each month, making due allowance for inflow, losses by evaporation and seepage from the reservoir at various elevations."[44]

Upon receiving Schuyler's report, Newell neither approved nor disapproved of its conclusions. Instead, he considered it incomplete because the report did not include the table Newell suggested Schuyler prepare. Newell would not forward any recommendations to Secretary Hitchcock, and thereby effectively suspended the project's development indefinitely. Writing to Secretary Hitchcock in January 1905, Newell stated that "whenever the Company is prepared to furnish a definite report covering the points previously considered, such report will be given very careful considerations, with a view to early action." By making his bias against the project known to Schuyler before he undertook his investigation, and by maintaining that Schuyler's report was not complete when it was forwarded, Newell revealed his view of the Agua Fria project as a competitive threat to the Salt River Project. Newell's obstinacy prohibited Beardsley from progressing with the

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block. Schuyler estimated the annual operation and maintenance costs to be $20,600. The sale of hydropower to Phoenix, Schuyler estimated would yield 2.5 times the revenue made from selling the power for groundwater pumping.

[44]Newell had previously been contacted by Mr. G. C. Morey, attorney for the Agua Fria Water and Land Company, regarding the development of the project. Newell to Schuyler, April 13, 1903, MWD, Land Restoration File. It is very doubtful that the Reclamation Service ever prepared a table showing the amount of water stored in the Roosevelt reservoir for each month.

Agua Fria project by effectively withholding the project's service land from settlement.[45]

Unable to convince the federal government to restore the Agua Fria project's service area, the Water and Land Company promulgated another plan. The Santa Fe Pacific Railroad helped Beardsley initiate a scheme to restore the Agua Fria lands to the public domain through a recently authorized federal law that provided for land exchanges. The success of this plan would not only restore the Agua Fria lands to entry, but would give the Water and Land Company's irrigation plan greater financial stability and confidence than could be furnished by the sale of potential water right contracts. The Indian Appropriations Act of 1904 permitted the exchange of privately held right of way lands for surveyed public lands if they were of equal acreage and assessed value. Through this provision, Beardsley proposed that the Santa Fe Railroad offer unused acreage it held on the Hopi Reservation (then called Moqui) in northern Arizona in exchange for lands in the Agua Fria project's service area. Once the railroad had secured the greater part, if not all of the service lands, Beardsley's organization would then purchase the acreage from Santa Fe at its standard scrip rate of $2.50 per acre. The impetus for Santa Fe to negotiate the deal was clear. The railroad held well over one million acres of unused land in Arizona. Most of this land had no prospect of development because of unavailable water. If Santa Fe could relinquish these valueless lands in exchange for lands under the project, it could not only make a large real estate sale to Beardsley but could expect future revenues from freighting produce grown within the development's service area. For Beardsley, obtaining the service area would give him collateral to finance the project, and at $2.50 per acre, he could realize a tremendous profit if he sold the acreage at Schuyler's $60 to $100 per acre estimate.[46]

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[45]Newell to Beardsley, February 3, 1909, MWD, Land Restoration File.

[46]Act of April 21, 1904, 33 Stat. 211. The legislation read: "any private land over which an Indian reservation has been extended by Executive order, may be exchanged at the discretion of the Secretary of the Interior and at the expense of the owner thereof, and under such rules and regulations as may be prescribed by the Secretary of the Interior, for vacant, non-mineral, non-timbered, surveyed public lands of equal area and value and situated in the same State or Territory." The extent of land grants to railroads in the western states was incredible. For

(Footnote Continued)

The Agua Fria developers and the Santa Fe Railroad reached an exchange agreement in 1908. They submitted the proposal to the General Land Office for examination. To insure that the railroad had offered a legitimate exchange of equal valued lands, the Land Office assigned federal inspector Raymond H. Satterwhite to review the proposal. Satterwhite disapproved the exchange after visiting the Hopi lands or base lands, and the project acreage or in lieu lands. He found that nearly two-thirds of the base Hopi lands were entirely valueless while the rest of the base lands were worth only thirty-five to fifty cents per acre. Satterwhite found the Agua Fria in lieu lands to be worth approximately twenty-five cents per acre.[47]

The seeming failure of the land exchange proposition, however, did not deter Santa Fe and the Agua Fria developers from continuing to demand the restoration of Agua Fria lands

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(Footnote Continued)
example, the Southern Pacific Railroad had been given one-tenth of the state of California (over 11 million acres) in federal land grants to encourage transportation development. In Arizona railroad companies still held over seven million acres in the 1940s. Golze, Reclamation in the United States, 15; Donald Worster, Rivers of Empire: Water, Aridity and the Growth of the American West, (New York: Pantheon Books, 1985), 101.

[47]Several other individuals representing the Agua Fria project were involved in the land exchange agreement including R. C. Kinney of New York City, and various Ohio businessmen who still had confidence in the project. William S. Greever, Arid Domain, The Santa Fe Railway and Its Western Land Grant, (Stanford: Stanford University Press, 1954), 89-93. Santa Fe's corporate records are located at the Kansas State Historical Society. Correspondence with their archivist failed to produce any substantive historical material concerning the railroad's activities with the Agua Fria project. The Santa Fe Railroad also worked simultaneously an exchange for lands at Gila Bend, south of the Agua Fria project. This exchange led to the development by F. A. Gillespie of the Gillespie Dam on the lower Gila River. Gillespie was constructed in 1921 as a multiple arch dam, the same design that Beardsley would adopt for his storage dam. Despite Satterwhite's objection to the exchange, he did recognize the excellent character of the Agua Fria watershed, that the project's engineering was simple and not costly, and that the project could reclaim up to 30,000 acres. Satterwhite apparently produced an extensive report following his investigation. Unfortunately, a diligent search failed to locate a copy of the document.

to public entry. In September 1908, Mr. Howel Jones, a representative from the Santa Fe Railroad, argued to the Department of the Interior that if the U.S. government did not need the lands for its own purposes, that is, for the Salt River Project, then it had "no paternalistic obligation in prohibiting private enterprise," even if it were not convinced that the Agua Fria project would succeed. Unpersuaded, Newell maintained his position that the Schuyler report did not present the necessary information upon which he could make a recommendation. Since he had received no additional data, Newell apparently believed the government could not permit investments in risky enterprises. Newly-appointed Secretary of the Interior James Garfield supported Newell's position. He stated that the government should not be forced to pass judgment on the scheme by opening the lands to settlement, and that the evidence submitted did not justify the government's direct or indirect approval of the matter. He qualified his statement, however, by stating that he did not object necessarily to the restoration of these lands for public entry generally, but recommended that if they be restored, they be so unconditionally and without preference to the project developers.[48]

In February 1909 Secretary Garfield changed the Interior Department's seven year policy. He instructed the General Land Office to restore unconditionally to settlement the lands desired by the Agua Fria project effective June 3 of

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[48]After Newell reconfirmed his position on the Agua Fria development, he stated that he would turn the matter over to Louis C. Hill, Supervising Engineer for the Reclamation Service in Phoenix and Arthur P. Davis, who would become the acting director of the Reclamation Service during Newell's two month absence from the country. Representatives from the Santa Fe Railroad hurriedly met with Hill and Davis at the next National Irrigation Congress meeting in Albuquerque to discuss the matter. Hill and Davis confirmed Newell's position that the Reclamation Service had no intention of recommending the project. However, they stated a willingness to recommend the restoration of the Agua Fria lands to reentry. Newell apparently modified his position upon his return to the Service. In December 1908 he wrote to Santa Fe and stated that either the lands be restored, giving anyone a chance to make entry, or thrown open to entry in such a manner that Santa Fe would have a preference. Garfield to Britton and Gray, Attorneys for Santa Fe Railroad, Feb., 24, 1909, MWD, Land Restoration File; Newell to Beardsley, Feb. 3, 1909, MWD, Land Restoration File; Britton and Gray to James Garfield, February 10, 1909, MWD, Land Restoration File.

that year. Newell did not object to the Secretary's order. Unfortunately, this did not exactly please Beardsley. In the same order, Garfield also ruled that these lands would not be subject to entry, the type of filing the Agua Fria developers needed to make, until one month later. Instead of claiming a victory after several years of effort, the long anticipated decision by the Secretary was disappointing news to Beardsley and his following. The Water and Land Company and Santa Fe Railroad not only failed to exchange lands for the service area, but now had to wait patiently for one month before they could make their filing. Since land speculators were well aware of the proposed Agua Fria development, Beardsley and his supporters feared that they would capitalize on the one month advantage and quickly file, with the expectation of selling their desert tracts for large profits upon the completion of the Agua Fria development. This concern inspired the project developers to petition Garfield's successor, Richard A. Ballinger, to modify his predecessor's order to permit filing by all concerns on the same date, June 3. The Land Company and Santa Fe realized that the Secretary's authority was probably limited to restoring the lands to public entry, but they believed he had no obligation "to defeat the purpose of a private reclamation project by giving preference to any person or class."[49]

Despite the Secretary's reversal, Newell continued to insist that the Agua Fria developers provide the Reclamation Service with additional data showing the amount of water that would be stored in the reservoir each month. This requirement, the Water and Land Company correctly believed for years, was completely unrealistic. Even Schuyler was startled, if not angered, by Newell's persistent demand. After learning of Newell's request, Schuyler wrote to Beardsley stating, "I am rather surprised that he [Newell] should take the position that the data given in my report

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[49]Secretary Garfield revoked the the 1902 withdrawal on February 27, 1909. The order was conveyed to Fred Bennett, Commissioner of the General Land Office, on March 5, 1909. The General Land Office made the decision public through The Arizona Gazette on March 8, 1909. Richard A. Ballinger was appointed Secretary of the Interior on the day the restoration order was issued by the General Land Office. Ballinger previously had been Commissioner of the General Land Office. "Notice of Restoration of Public Lands to Settlement and Entry," Frank Pierce, First Assistant Secretary of the Interior, March 5, 1909, Bureau of Land Management Records, Phoenix, Arizona; Unsigned to Richard A. Ballinger, Secretary of the Interior, March 27, 1909, MWD, Land Restoration File.

about the water supply is insufficient to justify such restoration." Schuyler added further that Newell's demand,

> is a most extraordinary request, as it would imply a foreknowledge of just how much land is to be under cultivation, what crops are to be cultivated, how much water is to be applied each month of the year, and how much water would be received in each month of the year from the run-off of the stream, and how much water would therefore be left after these amounts had been abstracted. It is clearly impossible for anyone to make up such a table, even approximately, and they have simply imposed impossible conditions. I cannot do it, and doubt if anyone can.[50]

By maintaining that Schuyler's feasibility study of the Agua Fria project was not complete, Newell continued to express his jaundiced view of the development. He had clearly objected to the project from the beginning, even before he saw any technical data on its possibilities. When it appeared that Schuyler would be asked to examine the project, Newell recommended that a table be prepared that was beyond reason. He then insisted for seven years that the Reclamation Service could not forward any recommendation to the Secretary because the report was incomplete without it. Schuyler's credentials as a hydraulic engineer were solid. Dismissing his report, which thoroughly endorsed the project, on specious grounds must show that Newell wanted to frustrate, or at least delay, the project until he could sufficiently further the Reclamation Service's Salt River Project.

Although unable to convince the Department of the Interior to revise its restoration order, the railroad remained undiscouraged. On the evening of June 2, 1909, defying the one month restriction, Santa Fe positioned a representative outside the General Land Office in Phoenix to ensure that the company held a good position to make its land exchange filing the next day. The following morning, the Land Office announced that it would not accept applications for over 320 acres because violent threats had been made against the office. When Santa Fe, third in line, offered the Land Office agent 50,000 acres in Hopi scrip, he would not exchange it. Having rejected Santa Fe's deeds and cash

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[50] Schuyler to Beardsley, March 2, 1909, MWD, Land Restoration File.

fees, the Land Office agent continued to process claims by individuals amounting to 25,000 acres.[51]

Angered by the General Land Office's refusal to accept the railroad's offer, Santa Fe Railroad's Howel Jones vehemently protested the decision to the Department of the Interior. The Secretary's office relented at first. It recognized that Santa Fe would have filed ahead of other individuals if the Phoenix Land Office agents had accepted its scrip. The Interior Department was willing, therefore, to grant the company preference over others who filed subsequently on the same acreage. Upon further review, however, the Secretary changed his mind and rejected the exchange, because he had been reminded that the base lands and the in lieu lands were not judged to be of equal value. The Interior Department concluded that the railroad's actions demonstrated that it was attempting to "get the better" of the Land Office. The Secretary's office provided the railroad with an alternative: if it would offer other, presumably more valuable base lands, the Interior Department would be willing to consider a new land exchange proposal without prejudice.[52]

Santa Fe readily accepted the Interior Department's alternative. Railroad officials revised their base land offer to include the same amount of acreage, but this time included lands in the eastern part of the Hopi Reservation.

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[51]Greever, Arid Domain, p. 91; The Arizona Democrat and The Arizona Gazette, June 3, 1909; The Arizona Republican, June 3, 4 and 6, 1909.

[52]Greever, Arid Lands, 91. The Santa Fe Pacific Railroad's greater land exchange activities in Arizona, which consisted of over 650,000 acres of both Hopi and Navajo lands, was strenuously opposed by the State Land Commissioner, Mulford Winsor. In 1914, Winsor wrote a philippic attacking the exchange, claiming that it was "one of the most flagrant land frauds ever attempted in the West, a typical Santa Fe Pacific Railroad Company job to mulct [sic] the Government of an empire and to realize a princely sum for that company's worthless holdings in the Painted Desert." He referred to the base Hopi and Navajo lands as "the most incomprehensibly worthless, inconceivably desolate, unbelievably God-forsaken scenery that eye ever viewed or the ingenuity of man ever thought of realizing upon." Winsor called the Agua Fria land exchange "this rotten Moqui scandal," "an outrageous fraud," and a "barefaced steal." Mulford Winsor, "The Moqui and Navajo Scheme," 1914, 5-15. Arizona Historical Collection, Hayden Library, Arizona State University, Tempe, Arizona.

Land Office agent F. C. Dezendorf was assigned to determine the value of exchanged lands. Dezendorf determined that the new tract was worth approximately the same as the undeveloped Agua Fria tract. This was probably because he did not add speculative value to the project lands as Agent Satterwhite had in his earlier assessment. Since the character of base acres that Santa Fe offered in its revised land exchange offer was appreciably the same as the acreage in its first offer, suggested that Satterwhite's examination did factor in speculative value which led him consequently to conclude that the base and lieu lands were not of par value. To insure that this agreement had better success than their previous effort, Beardsley and Santa Fe officials solicited the written support of several congressmen, Territorial Governor Richard E. Sloan, and many prominent Phoenix businessmen.[53]

In September 1910, Secretary Ballinger approved the revised land exchange and 39,000 acres were patented to the Santa Fe Railroad. Soon after the exchange, Beardsley's organization promised to acquire the tract for approximately $98,000 or $2.50 per acre, the railroad's scrip rate. Santa Fe officials quickly learned, however, that Beardsley did not have the financial resources to pay for all the lands immediately. Since the railroad had used valuable in lieu rights to acquire the Agua Fria lands and did not want to undertake the construction of an irrigation project itself,

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[53]Greever wrote that Dezendorf did not consider speculative value in computing the value of the Agua Fria lands. Those congressmen who supported the Agua Fria development were listed by Greever as: Senator Charles R. Dick, and Representatives Thomas E. Burton, Nicholas Longworth, H. P. Goebel, R. D. Cole, Albert Douglass, E. L. Taylor, Paul Howland, and J. M. Cox. Greever, Arid Lands, 91-92. Among the approximately twenty-five local residents supporting the project were: Lloyd B. Christy; H. J. McClung, banker; William J. Murphy, builder of the Arizona Canal; Joseph H. Kibbey, former Territorial Governor, judge and attorney; James H. McClintock, soldier, journalist and historian; John P. Orme; and Benjamin A. Fowler, first president of the Salt River Valley Water Users' Association. In his letter to the Secretary of the Interior, Fowler wrote that the project would be "a valuable contribution to the tax list, wealth, advancement and civilization of this or any other section of our country," and that "there is every reason why we of this valley should welcome this project and give it such aid as may be in our power." Fowler's comments are interesting since the Water Users' actions, twenty years later, would very much indicate that they did not want to see the project come to fruition.

it decided to work out an agreement whereby Beardsley would pay for the lands over time. In 1914, Santa Fe conveyed title of the Agua Fria property to Beardsley. The railroad only received a fractional payment for the acreage in that year. The remainder of the payment[54] totaling approximately $80,000, was not made until 1920.

Beardsley's difficulty in raising funds to acquire the service area from Santa Fe was probably due to the continued doubts concerning the project's viability. Beyond the Secretary's withdrawal and his difficulty with Santa Fe, Beardsley had another problem. His organization had been facing, since 1909, a legal challenge from the Maricopa Development Company. Maricopa petitioned the General Land Office to withdraw approval of the Agua Fria Water and Land Company's claim to develop the river because the Water and Land Company, as organized, held a dubious legal right in obtaining right of way for irrigation purposes. Maricopa also asserted that the Water and Land Company had not exercised legal due diligence in successfully forwarding its water storage claims over the previous twenty-three years. Maricopa charged that, if Beardsley's organization was permitted to develop the project, its placer gold claims located along the river would be inundated and destroyed.[55]

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[54]The exchange agreement was for 39,154.38 acres. Land patents for the Agua Fria acreage were conveyed to the Santa Fe Pacific Railroad in two transactions, one occurring on September 8, 1910 and the other on January 4, 1912. Santa Fe conveyed title to Beardsley and the Agua Fria Water and Land Company on April 3, and April 9, 1914. The consideration of payment, not necessarily the total payment, was $80,579.80. In 1914 Beardsley paid one-seventh of the payment to Santa Fe, paying the rest in 1920. Greever, Arid Lands, 92. Defendants exhibits 112, 113, 114, 115, Maricopa County Municipal Water Conservation District Number 1 v. Southwest Cotton and Valley Ranch, Arizona State Supreme Court Case No. 2872.

[55]Maricopa Development Company was incorporated in Maine and was operating twenty seven placer gold claims in Arizona. Maricopa began operations in the territory in 1907. The initial claim issued filed with the General Land Office against the Agua Fria Water and Land Company was dated August 9, 1909. On October 29, 1909 this complaint was dismissed. The Water and Land Company was asked to show cause by the Land Office again on September 21, 1910. This rule was suspended until December 1, 1911. On June 24, 1911, Maricopa petitioned the General Land Office for the

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The articles of incorporation of the Agua Fria Water and Land Company included provisions for the company to operate under a variety of business activities in addition to irrigation. These included mercantile, banking, general farming and real estate enterprises. Maricopa argued that these diverse purposes were illegitimate for an irrigation project, citing an accepted legal opinion written by United States Assistant Attorney General Van Devanter in 1899. Van Devanter had stated that canal and reservoir rights of way could not be approved to any company except to one formed specifically for the purposes of irrigation. The Agua Fria Water and Land Company did not incorporate only for this specific purpose. The fact the company now claimed that the canals and reservoirs were for the sole purpose of irrigation, Maricopa stated, "does not relieve the matter at all," adding that, "It [the Agua Fria Water and Land Company] is not what they say [it is] now." Maricopa concluded that right of way approval conveyed to the Agua Fria Water and Land Company was not within the jurisdiction of the General Land Office.

Maricopa also charged that the Water and Land Company had not shown legal diligence in forwarding its development over the previous twenty three years. According to federal law, the Water and Land Company had five years to initiate development of its irrigation works after right of way was granted. It had been more than ten years since the Water and Land Company had received its last right of way approval and no physical progress had been made. The only progress the company achieved was a recent survey of its right of way. Maricopa state this activity, however, was no more than a "miserable pretense" toward demonstrating progress. Furthermore, it also claimed that the Agua Fria Water and Land Company had been "utterly insolvent" since 1908. Maricopa cited a resolution recorded in the Water and Land Company's board meeting minutes in July 1908, which stated the company had been bankrupt for several years, that it was without funds to pay William Beardsley, and that the company was "wholly destitute of working capital."[56]

(Footnote Continued)
revocation of the Water and Land Company's easements for a third time. "In Re Agua Fria Water and Land Company, Before the Department of the Interior, General Land Office," June 24, 1911, MWD, Land Restoration File.

[56]The survey the Water and Land Company conducted was undertaken by A. L. Harris, an engineer formerly employed by the Reclamation Service. The survey work was completed between October 15, 1910 and July 1, 1911. Harris, in a sworn statement, stated that the survey cost $14,572 to
(Footnote Continued)

As further evidence of the Agua Fria Water and Land Company's inability to pursue its irrigation project, Maricopa attached to its complaint two inspection reports of the Water and Land Company's diversion dam and canal made by A. R. Cheever, agent for the General Land Office. Cheever reported that the company's diversion dam was incomplete with openings at both ends, that it was in "very poor condition," and that it was constructed of "very poor cement." He found the excavated portion of the canal to be washed out in several places and to be too high, relative to the diversion dam, to take water. The canal's present condition, Cheever concluded, was "of no value to anyone." As far as Cheever could determine, no work had been done at the sites for ten years and the only indication of legal diligence was Robert Jones' continued presence at Camp Dyer near the diversion dam. Cheever's recommendation was that the right of way granted to the Water and Land Company be revoked and the lands restored to the public domain.[57]

The following November, 1910, another damaging inspection report on the Agua Fria project was made to the General Land Office by agent George Hayworth. In his report, Hayworth generally confirmed Cheever's assessment of the diversion dam, canal, and the diversion dam's Dyer construction camp. Hayworth also investigated the legitimacy of the recent survey and apparently concluded that the work was credible. After interviewing several interested individuals and reviewing all available records, Hayworth concluded that the company expended approximately $214,000 in forwarding the project. He confirmed the bankruptcy of the company and the conveyance of deed to Beardsley, which stipulated that Beardsley had agreed to pay each stockholder of the company

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(Footnote Continued)
complete. Because the Water and Land Company was without monies and because it owed William Beardsley $9,607 for his services, it transferred ownership of title and rights to the company to him on July 10, 1908.

[57]The opening at the west end was attributable to 1897 flood damage. The east end opening was the sluiceway left to permit water and materials to pass through during construction. A. R. Cheever to Fred Dennett, June 25, 1909 and June 26, 1909. Copies of letters were attached to the Maricopa Development Company's complaint. Cheever also stated that Beardsley was "desirous of completing this project as quickly as possible and also for the necessary funds to accomplish this end." Although Beardsley could not provide evidence, he informed Cheever that he had expended $211,000 to date in developing the project. Cheever estimated project costs to date at $150,000 although he admitted that his figure was conservative.

fifty cents a share if he sold the company's assets. Hayworth was unsuccessful in obtaining adequate information from Beardsley concerning his activities and could only conclude that he did not have adequate resources to complete the work himself. Beardsley was said to be "very sanguine" about getting funding to complete the work. Unlike Cheever's report, Hayworth completed his investigation without making any recommendations.[58]

Beardsley responded to the Maricopa Development Company's complaint shortly after Hayworth's report was completed. However, for unknown reasons, the General Land Office did not prosecute Maricopa's claim for several years. The Land Office did not make its decision until four years later, in August 1915. Commissioner Clay Tallman denied Maricopa's petition on technical grounds. Tallman's ruling very narrowly stated that the Water and Land Company's diversion dam was completed before the canal and reservoir rights of way were granted in 1898 and 1901, respectively. Therefore, since the diversion dam "forms no part of the grant in question . . . it is not a subject for consideration by this office and the petition is accordingly denied." The Land Office had nothing to say about the multipurpose nature of the Water and Land Company's organization.[59]

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[58]George Hayworth, Special Agent, to Fred Dennett, Commissioner of the General Land Office, November 21, 1911, MWD, Land Restoration File. Beardsley's close associate was fellow Ohioan G. C. Morey. Stockholders John Orme and William Hancock had invested approximately $6,000 to $7,000 each in the company. Upon offering Beardsley their stock in the company, Hayworth learned from Orme and Harry Hancock, William's son, that they had given Beardsley the option to buy their stock so that they, as Hayworth wrote, could "save what they could out of the wreck." Hayworth reported that Orme and Hancock believed that Beardsley would "treat them fair." Beardsley, Hayworth reported, had personal assets reputedly worth $200,000.

[59]The Land Office decision stated further that "the diversion dam . . . forms no part of the [right of way] grant, the initial point [their emphasis] of the canal as above set forth being above and stated to be "at the east end of the diversion dam" [their emphasis again] hence it cannot be contended that any portion of the construction work of said dam or monies expended thereon were under the grant of right of way for the canal . . . ."
Unquestionably, the Land Office issued its ruling on very narrow and specific grounds. General Land Office to the Register and Receiver, Phoenix, Arizona, August 30, 1915, MWD, Land Restoration File.

The denial of Maricopa's petition, however, did not constitute a victory for Beardsley. In the same ruling, Commissioner Tallman denied the Water and Land Company's request to increase its acreage easement for its proposed storage reservoir. The Land Office not only denied the easement extension, but surprisingly gave the Water and Land Company thirty days to provide evidence that it had maintained its organization and corporate existence, had proceeded with actual construction, and had the means to complete its irrigation plans. Failure to do this, the ruling stated, would result in the forfeiture of the company's grants. The Land Office based its ruling on both the Water and Land Company's 1908 resolution declaring itself insolvent and the absence of visible progress in constructing its water works. How Tallman reasoned this after denying Maricopa's complaint, which was based on the same criticisms of Beardsley's organization,[60] makes no apparent sense.

The Water and Land Company answered the General Land Office requirement to show cause in October. In a lengthy response, the company argued that Hayworth's report was "erroneous and misleading." It insisted that the diversion dam had withstood the heaviest floods over the previous twenty years, that the structure was of "superior character," and "in an almost perfect state of preservation." The company also contested the amount of money invested in the project to date. The Water and Land Company now claimed that approximately $381,000 had been invested in the project as of January 1915, disputing the $214,000 figure reported by agent Hayworth. Concerning delays in advancing the project, the company said that all "great works" are usually subject to delay. The company made the claim that the project had been postponed for seven years, 1902 to 1909, as a result of the federal government's

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[60] In April 1913, Beardsley requested that the Water and Land Company's easement be increased to include approximately two thousand additional acres, or a total of 3,400 acres, to its proposed reservoir lands. The proposed storage dam was originally designed to rise one hundred feet. The company's updated plan was to build a structure 170 feet high which would require more easement acreage. The Land Office report stated, "it is contrary to the policy of the Department to grant to original applicants new rights on the same location, where it does not appear that the original grant has been utilized by actual construction sufficient to indicate good faith, and showing of financial ability to continue the works to completion within a reasonable time as measured by the magnitude of the project under construction . . . ."

efforts to construct the Salt River Project. In demonstrating diligence, the company argued that it would not be acquiring a vast tract of land from Santa Fe unless it intended to convey water to it. The company stated it was confident that it had the financial ability to complete the work because Beardsley was in active negotiations to meet the project's financial requirements. The company implied that it would have already attracted sufficient investment if not for Maricopa's 1909 petition to show cause, which dissuaded potential financiers, and the onset of World War I. Beardsley's group argued that claims of insolvency were "of no moment" and that the company had always maintained its corporate existence. The Water and Land Company concluded its defense by stating,

> A vast acreage of barren desert land is waiting for water. The waters of the Agua Fria River have been running to waste for, perhaps, many thousands of years and will continue to do so for as many years to come unless the government allows someone with the pluck and determination of these gentlemen to divert them to beneficial use, and who is there qualified or equipped to do this better than Mr. Beardsley and his associates. No one is now asking to take their place.[61]

Again, the General Land Office delayed its ruling in deciding the Water and Land Company's fate. Two years after the company's response, in October 1917, the Land Office granted an easement for the construction of the diversion dam, not to the Water and Land Company, but to William Beardsley on his own behalf. One year later, the Land

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[61]William H. Beardsley to the Commissioner of the General Land Office, October 26, 1915, MWD, Land Restoration File. Beardsley's response was forwarded well after the thirty day limit. It is unclear how Beardsley justified the Water and Land Company's $381,000 expense. Certainly he would have been motivated to present the largest investment figure possible. Beardsley also claimed that $16,796 was expended on the survey work and not the $1,400 reported by Hayworth. He also believed that the project could be completed for $2 million and not $3 million as Hayworth had asserted. Regarding Hayworth's report, Beardsley's reply stated generally that "The special agent in his report seems to have gone out of his way in making statements for the purpose of showing that there is a lack of good faith on the part of Mr. Beardsley and his associates and that it is impossible for them to finance the project."

Office also approved Beardsley's request to revise the permit for a larger reservoir.[62]

Throughout the several years of controversy with Maricopa, the Land Office never vigorously prosecuted Beardsley's organization. It seems that the Land Office never, at any time, intended to institute forfeiture proceedings against Beardsley and the Water and Land Company. It also became apparent that the Land Office never seriously examined the Water and Land Company's financial ability to complete its irrigation plans. Instead, the General Land Office ultimately conceded all points and decided that the existing Agua Fria project facilities were "in a good state of preservation" and that the completion of the project was within Beardsley's financial abilities. The Land Office, in the end, only emphasized one practical engineering question concerning the project. It asked whether the Agua Fria River carried enough water to warrant the construction of a storage reservoir.[63]

After reviewing stream flow measurements collected over a four-year period, the only useful information the Land Office admitted it had obtained was that the Agua Fria River's flow varied significantly from year to year. Although the Agua Fria would fill the reservoir for the four years examined, the Land Office was still not confident that the river could provide enough water over a sustained period to make the project successful. Nevertheless, the Land Office again absolved itself by stating that insufficient evidence did not warrant the conclusion that the project was impracticable.[64]

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[62]Why the General Land Office delayed its decision concerning the Maricopa petition for four years and again delayed its decision for two years, particularly after it required the Water and Land Company to show cause within thirty days, is not known. The Land Office approved the diversion dam easement on October 24, 1917, and the enlargement of the reservoir on October 18, 1918. William Stry, Commissioner of the General Land Office to the Register and Receiver, General Land Office, Phoenix, Arizona, January 29, 1924, MWD, Land Restoration File.

[63]It seems that the Water and Land Company could lose its rights of way only by relinquishment, which Beardlsey was completely unwilling to do, or by judicial proceedings, which the Land Office apparently had no interest in pursuing.

[64]The Land Office also considered the effect of storing
(Footnote Continued)

The several favorable decisions made by the General Land Office cleared the way for William Beardsley to develop the Agua Fria project in 1918. No further complaints were heard from the Maricopa Development Company, probably because their mining claims had proven unproductive. Although he had not completed payment to Santa Fe for purchase of the service area, Beardsley held title to the acreage and could use it for collateral to refinance the project. All the necessary easements to complete the diversion dam and canal and to construct the reservoir dam had been obtained. Just as in 1898, all that was needed for the project's completion was for Beardsley to find adequate funding to begin once again.

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water on the Agua Fria River on the general flow of the Colorado River. They concluded such storage would have no effect on the Colorado.

Chapter IV, Construction of Pleasant Dam and the Agua Fria Project, 1919-1927

In 1914 several European events combined to create a World War. To fuel the war effort, tremendous increases in the production of food and materials were needed. Because of the variety of wartime goods made from cotton, demand for the fiber greatly increased. Consequently, in Arizona, nearly every acre in the Salt River Valley was planted in long staple cotton. Production of the crop in Maricopa County grew from a few thousand acres before 1915 to approximately 190,000 acres during the height of the war. With the potential for an additional forty thousand acres of cultivated fertile land in the Valley, Beardsley believed conditions were now right to build a water storage dam on the Agua Fria River.[65]

Because of the wartime economy, Beardsley was able to sell six thousand acres of the project's service area to the Goodyear Tire and Rubber Company in 1916. Goodyear purchased the lands to meet its cotton needs for its tire manufacturing. Under the sale agreement, Beardsley sold the land for $20 per acre. Although this was appreciably more than the $2.50 per acre rate he received from Santa Fe, Beardsley probably only realized one third of the total amount because he still owed the railroad $80,000 from their sale agreement. Under the Goodyear sale, Beardsley also provided the tire company with a two-year option to purchase the project's remaining acres including the development's irrigation rights of way. Construction now looked promising even if Beardsley might not retain an interest in the project. Yet by 1918, Goodyear had not exercised its purchase option because it had not received necessary federal authority to make a larger investment in the development. Goodyear's corporate planning was regulated strictly by the federal government during the war because the company's tire production was an essential military product. Goodyear, hopeful of winning federal approval soon, asked Beardsley to extend the option for another year. Believing that the delay would amount to a lost opportunity elsewhere, Beardsley refused and tried to market the project to other concerns.[66]

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[65]Beyond cotton production, investors became interested in the Agua Fria acreage for cattle production.

[66]From the date of the railroad exchange agreement, Beardsley had been attempting to finance the project to a variety of businesses. He spoke to the Babbitt family of Flagstaff, the Chicago Exploration Company, a meat packing

(Footnote Continued)

Through the conclusion of the European War and beyond, Beardsley assiduously continued negotiating the financing of the project. His efforts now centered in New York City, where he spoke to W. R. Grace and Company, the Niagara Falls Power Company, the Goodrich Rubber Company, and the executors of a private estate, among many others. Beardsley also discussed the project's development with the Dupont family of Delaware, the Foley Brothers of St. Louis, and the Dunlop Tire Company of England. Surprisingly, he could have sold the project to any of the three rubber companies which wanted to buy the project outright. He refused to sell, however, because he apparently changed his mind and now wanted to maintain a personal interest in the development. Despite many meetings over a five-year period, Beardsley did not acquire any additional financing and the Agua Fria project remained uncompleted.[67]

The wartime economy presented an opportune time for the completion of Beardsley's project. Since agricultural production and crop values peaked nationally, the Agua Fria

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(Footnote Continued)
house, and various investors from New York, San Diego, Los Angeles, San Francisco, and Minneapolis. Beardsley even attempted to sell project lands to a British investment syndicate. Testimony by Robert O. Beardsley, Maricopa County Municipal Water Conservation District Number One v. Southwest Cotton and Valley Ranch, Arizona Supreme Court, Case No. 2872, 3595 ff. Lands sold to Goodyear were in the southeast corner of the project's service area. The agreement was made on October 26, 1916 and was signed by William Beardsley and Joseph R. Loftus. According to Robert Beardsley, neither he nor his father knew that Loftus represented the Goodyear Company at the time of the agreement. The Goodyear property became known as the Litchfield Farm, named after Paul W. Litchfield, Vice President of the company. The present community of Litchfield Park is named in honor of him. Goodyear also purchased a large tract of land in the southeastern area of the Valley. Goodyear stated that it had not received permission to purchase the remaining acres from the capital investment committee. This committee was part of the federal War Industries Board which was established by the Council of National Defense in 1917. The Board was given broadly based powers to determine national economic needs including manufacturing priorities, price fixing and the purchase of supplies for the U.S. and the Allies.

[67]Testimony by Robert Beardsley, MWD v. Southwest Cotton, 3602; "History of Southwest Cotton Negotiations," MWD, Southwest Cotton File.

lands were prime for development. After the war, the opportunity ended abruptly as the farming market collapsed nationally. Heavy crop inventories produced to meet an international wartime economy quickly glutted the domestic market. A nation-wide farming depression resulted and prices for most agricultural products, including cotton, dropped precipitously. Selling the Agua Fria project as a potentially lucrative development was not promising in the years following the war.[68]

Realizing that he probably would not attract added investment, and not having earned enough from the sale of lands to Goodyear to begin construction, Beardsley, nevertheless, decided to draft design plans for the storage dam and for the completion of the diversion dam and canal. To perform the engineering, Beardsley hired Carl Pleasant. (See photo AZ-11-47.) An ambitious and well regarded engineer and construction contractor from Tulsa, Oklahoma, Pleasant held both undergraduate and graduate degrees in engineering from the University of Kansas. In college, Pleasant was a talented student having captained the Jayhawk football team his senior year while serving as class president. Pleasant began his engineering career early by successfully bidding on a construction contract while still an undergraduate. Only in his thirties when he met Beardsley, Pleasant had already constructed many public works projects in several states, including Florida, Texas and New Mexico. With Pleasant's involvement,[69] the Agua Fria plan began to progress in earnest.

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[68]The farming depression, beginning in 1921, caused total farm receipts to decline nationally by one third from 1918 to 1932. The only progress Beardsley was able to make after the war was to extend his easements, which began to reach their five year limit in the early 1920s. After a series of filings, Beardsley was able to extend the period established by the General Land Office for the initiation of construction from 1920 to 1925. Apparently, the issue of legal due diligence was not considered when the easement extensions were granted. Defendant's exhibits (MWD) 116-119, MWD v. Southwest Cotton Company.

[69]Why Beardsley decided to begin design planning is uncertain. Possibly, Pleasant heard of the development, approached Beardsley and convinced him to initiate the engineering design. Carl Pleasant was born in Lyndon, Kansas in 1886. He received an undergraduate degree in engineering from the University of Kansas in 1909 and a graduate degree in engineering the following year.

Under Pleasant's guidance, Beardsley hired the Oklahoma firm of Peckham and James to draft design plans for the construction of the storage dam. It is doubtful that this firm had any previous experience in dam design. They likely had been hired by Pleasant for previous projects. Since the inception of the project in the 1890s, Beardsley had always planned the storage dam as a masonry gravity structure, similar in design to the diversion dam but much larger. Peckham and James designed a very different dam, one that had a more rational structural form.[70]

By the 1920s, the technology involved in building large storage dams had progressed substantially from the 1890s. Although gravity dam designs had been used successfully for many sites, their characteristics could not compete technologically and economically with modern arch dams. The gravity design succeeded because its monumental mass resisted the horizontal component of water pressure through the natural force of gravity pulling the structure down. Simply stated, the tremendous weight of the gravity monolith was sufficient to prevent the water pressure from pushing aside or tipping over the dam. However, the design required an excessive amount of material, primarily because gravity dams need a high base-to-height ratio to succeed, generally at least two feet in width to three feet in height. The inefficient use of construction materials needed in the gravity design made its costly to build.[71]

Arch dams provided several design advantages over gravity works. Unlike the gravity design, which resisted or carried all of the reservoir's water load through gravity action, the arch design carried at least part of the hydrostatic pressure to the dam's abutment walls through the structure's arch action. The hydrostatic forces that were exerted on the dam itself were safely handled because arching placed the dam's construction material, usually concrete, in compression. The arch design could impound the same amount of water as a gravity dam, but used appreciably less material because it could afford a much greater base width to height ratio. A gravity dam with its greater base also had an inherent weakness. Although it gave an appearance of stability and safety because of its size, it potentially was subject to significant hydrostatic uplift pressure. Water

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[70]The dam's design and hydrostatic stress sheets were made by Ralph S. James of Peckham and James, Oklahoma City, Oklahoma.

[71]Although many gravity dams are constructed of masonry, there are masonry dams that are not gravity designed but are true arch dams.

seepage between the dam and its extended bedrock foundation could cause the dam to slide along horizontal joints at the dam's base resulting in the structure weakening or failing. The potential uplift pressure that was attendant in the gravity design was not a factor in the arch design. However, arch dams did require strong rock foundations in order to resist the structure's arch action.[72]

Because financial considerations controlled the status of Agua Fria project, Peckham and James did not ever consider the more expensive gravity design. The amount of quarried stone required for a gravity dam would have made its cost prohibitive. The Oklahoma engineers also were not satisfied with a single arch design because the excessive width of the dam site made the design impractical, if not impossible. The design they sought needed to meet the conditions of the dam site at the very least possible cost. Peckham and James subsequently selected the multiple arch design.

The multiple arch design was first used in the early nineteenth century in India. Although the first multiple arch dam was a success, the design was not used again through the remainder of the century. The first multiple arch built in the United States was constructed in California. Designed by John S. Eastwood, the sixty-one foot high Hume Lake Dam was constructed in 1908 for the privately held Hume Bennett Lumber Company.[73]

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[72]Basically, there is a vertical and horizontal component to hydrostatic pressure being exerted against a dam. The resulting force is designed to fall in the middle third of the dam's foundation. For a clear explanation, including graphics, of vertical and horizontal water pressure acting on a dam's upstream face, see Donald C. Jackson's discussion in "John S. Eastwood and the Mountain Dell Dam," The Journal of the Society For Industrial Archeology 5 (1979): 37-38. Many masonry dams constructed in the modern era were arched. It was believed that arching a gravity design provided an extra degree of safety. The Salt River Project's Roosevelt Dam, a gravity design, was arched. Not all arch dams, however, succeed because of arch action. Hoover Dam, in appearance a concrete arch design, was sufficiently over-built to perform safely as a gravity structure.

[73]In his chapter in Wegmann's volume, Noetzli stated that the first multiple arch dam constructed was the Meer Allum Dam in Southern India in 1806. The design was not used again until after the turn of the century when the Belubula Dam in New South Wales, Australia, was constructed.
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The design was selected for the Agua Fria project because Eastwood and others had proven that the design was appealing economically. By the mid 1920s, Eastwood had designed the construction of over twenty multiple arch structures. The design absolutely minimized the use of construction materials. It used the smallest quantity of concrete of any type of known concrete or masonry dam design. Instead of a single concrete arch span, the multiple arch used a series of wide-spanned, thin-arched, inclined barrels supported by double-walled, hollow buttresses. The design succeeded similarly to the single arch. The reservoir's water load was absorbed at the crown of the arched barrels and distributed through its piers and haunches to the buttresses and foundation. The design could support the rise of water to an appreciable height by using a minimum amount of concrete.[74]

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Although other engineers, including Wegmann, designed multiple arch dams in the United States, Eastwood's Hume Lake Dam was the first constructed. Wegmann, The Design and Construction of Dams, 470. For a discussion on the construction of Hume Lake Dam, see Jackson, "A History of Water in the American West," 272-315. At the time of the construction of the Agua Fria dam about 30 multiple arch dams had been constructed in the United States.

[74]For a list of Eastwood's dams, see Jackson, "A History of Water in the American West," 6. For a discussion of multiple arch dams constructed in the American East by designers Gardiner S. Williams, and William Barclay Parsons, Harry de Berkeley Parsons and Walter J. Douglas, see again Jackson, "A History of Water in the American West," 548-553. Since Eastwood died in 1924, he had no involvement in the Agua Fria project. However, Eastwood did develop plans for the Salt River Valley Water Users' Mormon Flat dam site. Nothing ever became of this design. Concerning the amount of concrete needed in multiple arch dams compared to other designs see Noetzli's, comments in Wegmann, The Design and Construction of Dams, 439. A dramatic example contrasting material intensity of the multiple arch design as opposed to the gravity design can be made by comparing the Agua Fria dam with the Reclamation Service's Roosevelt Dam. Although approximately sixty-five feet higher than the Agua Fria structure, Roosevelt required 342,000 cubic yards of masonry, not including concrete, to construct. The Agua Fria dam used only a total of 75,000 cubic yards of material in its construction. Though less high, the Agua Fria dam was twice the crest length of Roosevelt. Even Schuyler's reservoir dam, significantly shorter, would use 160,000 cubic yards of material.

Beyond its cost incentives, the design also offered several engineering advantages. Because of a greatly reduced foundation contact, uplift pressure was all but eliminated. The combined weight of the hydrostatic force exerted on the inclined upstream face of the dam added to the dam's own mass and produced a resultant force which fell nearly directly along the center line of the structure's foundation. This provided added stability against overturning in the event that the dam was overtopped by flood. The design of the upstream arches also put the concrete barrels in compression. The reduction in concrete used in construction minimized the amount of heat given off during the curing process and consequently reduced possible cracking in the structure. Because of the dam's unique characteristics, John Eastwood referred to it as "the ultimate dam." Locally, the multiple arch design was winning popular support. Gillespie Dam, a privately financed diversion work on the Gila River constructed in 1921, employed a multiple arch design. Cave Creek Dam, constructed north of Phoenix in 1922-1923 by a consortium of interests including the city of Phoenix and the Salt River Valley Water Users' Association, used a multiple arch design. On the Gila River, east of Phoenix, the U. S. Indian Irrigation Service constructed in 1925-1928 a unique, modified version of the multiple arch using egg-shaped multiple domes.[75]

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[75]Several multiple arch dams have been over topped by flood. None have failed as a result. The elaborate form work in constructing the design's arches made the multiple arch dam's construction more labor intensive than mass gravity designs. The savings in construction materials and freighting costs, however, more than offset the additional costs in labor. Cave Creek Flood Control Dam was designed by Eastwood. The dam used little material considering its size. With a sixteen hundred foot crest length, an average height of over seventy feet, and thirty-seven buttresses, the dam only needed 19,000 cubic yards of concrete to construct. Jackson, "A History of Water in the American West," 637-653; Wegmann, The Design and Construction of Dams, 482-486. Noetzli referred to the Cave Creek Dam as one of the "most remarkable and boldest structures of the multiple-arch type that has been built." The U.S. Indian Service constructed Coolidge Dam using egg-shaped multiple domes in 1925-1928. David M. Introcaso, "Coolidge Dam," 1986, National Park Service, HAER Report, AZ-7, copy available at the Salt River Project Research Archives. The multiple arch dam serves as an excellent structural example of John Kouwenhoven's idea of the "vernacular" in American architectural design, see John A. Kouwenhoven, The Arts in

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Peckham and James designed the Agua Fria project's storage dam as the highest multiple arch structure in the world. Their design was very similar to one planned by Fred A. Noetzli, for the Verde River, east of Phoenix. Originally named Frog Tanks, the Peckham and James dam was planned to rise 171 feet above the stream bed or 218 feet above bedrock. It would have a crest length of 1,800 feet and impound a maximum of 173,000 acre feet of water. The spillway's twenty-nine taintor gates, operated by gasoline motor or by hand powered mechanisms, were planned for a natural rock saddle located approximately 750 feet northwest of the dam's west end. Water would be released from the spillway when it reached 154 feet above stream bed. Discharge capacity through the spillway was computed at approximately 105,000 cubic feet per second. Normal water releases were designed to be made through a six-foot diameter steel penstock at the base of the dam's east end. Two additional low level outlets were provided for future hydropower production.

As originally planned, Frog Tanks Dam was designed to be constructed straight across the Agua Fria. But because of topographic and bedrock conditions, the dam's alignment was modified so that it would take on a broad V-shape in appearance, with the apex pointing downstream. Specifications for the dam called for thirty, constant radius, forty-four foot span arches. Thicknesses at the arch crown varied from 6.90 feet at bedrock to 1.50 feet at one hundred feet above stream bed. Steel reinforcing bars were added at both intrados and extrados throughout the length of the arches. The twenty eight buttresses were hollow or double walled, spaced sixty feet on centers. They were solid to stream bed and tapered, on the inside face only, to a thickness of 1.5 feet at 150 feet above stream bed. The buttress walls were tied together at the downstream face with a sixteen-inch thick reinforced concrete tie wall. Each buttress leg was tied with vertical webs or diaphragms to conform to a standard column design for an H section. A heavily steel reinforced concrete slab known as a water slab was placed on the upstream face of the buttress. It varied in thickness from 5.45 feet at bedrock to 2.07 feet at 150 feet above stream bed. The upstream face of the water slab made an angle of forty eight degrees from the horizontal. The buttresses generally received steel reinforcement placed vertically and inclined parallel to the upstream face of the buttresses. Unlike some of

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Modern American Civilization. (New York: W. W. Norton and Company, 1948). Kouwenhoven's volume was originally published under the title Made in America.

Eastwood's dams, the buttresses were not planned to have external horizontal struts between the buttresses.

The top of the dam was not planned to have a typical crest finish. It was customary to cut the arches off horizontally at the top of the buttresses. In the Agua Fria dam, the arches ended abruptly in a horizontal plane three feet below the high water level. Water above the top of the arches and the dam's crest would be retained by a two foot face slab and a three foot cantilever wall tied to the buttresses. This modification provided a large savings in material because it eliminated the need to extend the buttresses up to the water line. This resulted in making the downstream buttress walls steeper and shorter in the upstream and downstream direction. (See Appendix 3 for a line drawing showing Pleasant Dam's structural elements.)[76]

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[76]Noetzli designed a multiple arch dam for the Paradise Verde Irrigation District which planned to irrigate 96,000 acres north of Phoenix. Although the site was used in the 1940s for a dam, the multiple arch design was not selected. Eastwood saw Noetzli's use of the multiple arch as mere "imitation" of his work. Noetzli was, as Jackson wrote, "capitalizing on his [Eastwood's] earlier efforts to promote multiple arch dams." Jackson, "A History of Water in the American West," 553. Fred A. Noetzli, "Improved Type of Multiple-Arch Dam," Transactions of the American Society of Civil Engineers 87 (1924): 342-413. For biographic information on Noetzli, see "Fred Adolph Noetzli," Transactions of the American Society of Civil Engineers 99 (1934): 1496-1497. Peckham and James were assisted in their design work by Charles E. Griggs who served as chief engineer for the Agua Fria project. "Lake Pleasant Dam, Near Phoenix, Will Be the Highest Multiple Arch Dam in the World," Modern Irrigation 3 (June 1927): 30-31, 60. Robert Beardsley to Frank Trott, January 31, 1927, MWD, Construction File; Charles E. Griggs to George L. Davenport, August 13, 1925, MWD, Report File; Charles E. Griggs, "Highest Multiple Arch Dam in the United States," Western Construction News 1 (March 25, 1926): 23-27; "Lake Pleasant Dam," nd, MWD, Waddell Dam 1925-1930 File. Sometime during construction (1926-1927) the dam's name was changed to Pleasant Dam after the contractor. Fourteen of the spillway's twenty nine taintor gates were twenty-three feet wide by sixteen feet high. Fifteen gates were twenty-three feet wide and ten feet high. Between each gate were planned two foot wide buttresses, twenty nine in total. The spillway's length was also 750 feet. The three penstock openings measured six feet in diameter. Only one was fitted for water releases with a two hundred foot discharge tunnel,

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In the fall of 1925 stresses in the structure were computed by Peckham and James and checked by George L. Davenport, water department director for the Santa Fe Railroad. Davenport had previous experience with the multiple arch design since he reviewed Eastwood's Lake Hodges Dam in 1917. Buttress stresses were computed using two methods. The first method considered the arches and buttresses as acting separately. The second assumed the arches and buttresses as acting together as a monolith. The first method gave compressive stresses of 450 pounds per square inch at the toe of a horizontal section at bedrock with no tension. The second method gave 453 pounds per square inch in compression and seventy eight pounds in tensile stress. The maximum sliding factor found by Davenport was .817 which he did not consider excessive. The method of computing stresses in the arches used the elastic theory and included concrete and water loads, rib shortening effects, and a temperature drop of twenty six degrees at the crest of the dam. Maximum compressive stress in the arches was computed at nearly seven hundred pounds at the intrados of the spring line in the arch sixty feet below the top of the dam. Maximum tensile stress occurred in the arch at the top of the dam amounted to 230 pounds. Second principal or inclined tensile stresses in the buttresses were not computed. Although Davenport mentioned these "casually," the theory behind these stresses was not generally developed at the time.[77]

After reviewing the design and computations, Davenport made his recommendation in October 1925. Davenport's comments principally concerned a further examination of the character of the bedrock foundation and the shape and size of specific sections of the dam's arches and buttresses. He advised that the upper portion of the arches be redesigned to reduce eccentric loading and that the arches be made more elliptical or that they should rise more vertically toward the top, similar to Eastwood's multiple arch design. He recommended that the thickness of the upstream buttress face or water slab be increased in the lower portion of the dam, and that the buttresses be made longer in the upstream and downstream direction. He also suggested that the design add a hydroelectric generating plant. Davenport concluded

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and a regulating fifty-four inch needle valve. To date the two other penstocks have not been used for power production. The arches had a rise of 18.25 feet.

[77] "Lake Pleasant Dam," MWD, ADWR 1925-1930 File. Computing the dam's secondary tensile stresses would play an important part in determining the safety of the structure after completion.

generally that the design plans "will secure a safe structure . . . ." He admitted, however, that his examination was based only on general engineering principles. He cautioned Beardsley to consult with engineers who had specialized in the multiple arch design because, as he stated, "the methods of design of multiple arch dams are not entirely agreed upon by engineers."[78]

Upon Davenport's suggestion, Beardsley contacted the Massachusetts engineering firm of Stone and Webster. Though a reputable firm, Stone and Webster had no previous expertise in multiple arch technology. After a field examination and office study, Stone and Webster also endorsed the project stating that "We see no objection to the use of a multiple arch type of dam for this development . . . ." Although they recommended "some changes" to increase the dam's safety factor, they concluded that, "The plans we have examined appear in general satisfactory . . . ."[79]

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[78]George L. Davenport, "Report on Stability of the Beardsley Land and Investment Company's Proposed Multiple Arch Dam, on the Agua Fria River, Arizona," October 21, 1925, MWD, Arizona Department of Water Resources (ADWR) Waddell Dam 1925-1930 File.

[79]Jackson, "A History of Water in the American West," 588. Diamond drilling tests were conducted at the dam's foundation by A. L. Harris. The rock, resembling quartzite, was found to have satisfactory characteristics by John L. Harper, vice president of the Niagara Falls Power Company, A. L. Harris, and R. S. Masson, a consulting engineer from Los Angeles. Bedrock was hit between twenty seven and forty seven feet below stream bed elevation. Memo, Charles E. Griggs, March 1, 1926, MWD, 1920s Construction Report File; Robert Beardsley to George L. Davenport, August 13, 1925, MWD, Report File. George L. Davenport, "Report on Stability of the Beardsley Land and Investment Company's Proposed Multiple Arch Dam, on the Agua Fria River, Arizona;" George L. Davenport, "Supplemental Report on Some Features of the Design of the Beardsley Dam, Agua Fria River, Arizona," MWD, Report File; "Summary of Recommendations on Beardsley Dam," contained in a letter from the Atchison, Topeka and Santa Fe Railway Company, Coast Lines to Robert O. Beardsley, October 9, 1926, MWD, 1920s Construction File. J. H. Manning, Vice President, Division of Construction and Engineering, Stone and Webster to Brandon, Gordon and Waddell, November 11, 1925, MWD, 1920s Construction Reports File. Stone and Webster's only familiarity with the multiple arch was when it "rebuffed" Eastwood's multiple arch design for the Big

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The review and design approval of the project's multiple arch dam markedly increased the attractiveness of Beardsley's plans to likely investors. But for unknown reasons, Beardsley ceased soliciting investment in the project. Having had limited success in attracting outside investors over many years, Beardsley finally abandoned the idea and planned to finance the project himself. In June 1925, he formed the Beardsley-Agua Fria Water Conservation District. The District was organized under a 1921 state law which encouraged private organizations to form water irrigation districts principally by permitting these districts financing and other organization controls. Beardsley obviously saw the advantages of the law's provisions. To run the District, he appointed his son, Robert Beardsley, and two other business associates. (See photo AZ-11-8.) Under the District's organization, the Beardsleys would finance the project independently through the sale of District bonds.[80]

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Creek hydroelectric power system in California in 1912. Jackson, "A History of Water in the American West," 237-238, 245.

[80]Beardsley had not attracted any investment since his sale to the Goodyear Company in 1916. According to Robert Beardsley, his father broke off negotiations with the Foley Brothers of St. Louis in January 1925 to undertake private financing. Having pursued the development of the project for over thirty years and growing elderly, Beardsley probably realized that if he did not arrange the financing he would never see the construction of the project. The Beardsley-Agua Fria Water District was organized under Arizona State law, Chapter 149, Session laws of 1921. Robert Beardsley's other associates in the formation of the Water District were Clarence S. Johnson and L. M. Laney. The first elected District officers were Mary M. Bell, L. M. Laney, and Beardsley's attorney, P. H. Hayes. Since the partially completed diversion dam and canal, the engineering plans and specifications, the general plan of development and the project's rights of way and water appropriations were held by William Beardsley, he conveyed them to the Beardsley-Agua Fria Water Conservation District under an agreement made on June 18, 1925. Under that same agreement, William Beardsley required payment of $193,000 for the costs incurred in the construction of the diversion dam and canal. This was significantly less than the over $300,000 he reported to have invested during the General Land Office's investigation in the 1910s. Beardsley Land and Investment Company to the Maricopa County Municipal Water Conservation District Number One, November 14, 1928, MWD, Finance File.

The construction of Frog Tanks Dam and the completion of the diversion dam and canal was estimated to cost $3.325 million. The District prepared a bond issue for that amount. Before the District could market its securities, it needed to obtain authority from the State Certification Committee. Made up of the Attorney General, the State Engineer, and the Superintendent of Banks, the Certification Committee needed to determine the feasibility of the project's engineering before it would consider permitting the sale of the District's bonds. Upon evaluation of the Frog Tanks design and plans to complete the distribution system, State Engineer W. C. Lefebvre found the plans sound. Upon Lefebvre's recommendation, the committee estimated the proportionate amount of bonded indebtedness as compared to the estimated value of the project when completed. The committee approved the bond issue because the project's worth, estimated at eleven million dollars after completion, provided sufficient security against the bonded indebtedness.[81]

Soon after receiving bonding approval from the state, the Beardsley-Agua Fria Water Conservation District changed its name to the Maricopa County Municipal Water Conservation District Number One in November. The bonds would be issued under the new name. As the Maricopa County Water District, a name connoting the stability of a government entity, Beardsley believed that the organization's securities would receive greater visibility and confidence in the financial market.[82]

One month after the formation of the Maricopa Water District, agreement was reached with Carl Pleasant for the construction of the project. The construction contract was signed on December 20, 1925. Under the terms of the contract, the financial arrangements were modified

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[81]The bonds were issued in the denomination of $1,000. They would yield six percent interest annually and mature in thirty years. The committee computed the project's value at $11 million by combining the value of the District's lands after construction, the proceeds from the bonds and the value of the irrigation system. The Superintendent of Banks was A. T. Hammons and the Attorney General was J. W. Murphy. "Finding, In the Matter of the Application of the Beardsley-Agua Fria Water Conservation District For the Certification of Its First Series of Bonds in the Sum and Amount of $3,325,000," October 21, 1925, MWD, Finance File.

[82]The State Certification Committee approved the District's bonds on October 21, 1925. The District changed its name on November 3, 1925.

significantly. Instead of the District marketing the bonds, Pleasant agreed to receive payment for the construction of the project in District bonds. This meant that the responsibility for selling the securities now belonged to Pleasant, not Beardsley or the District. Work would begin as soon as Pleasant found a financial house to purchase the District's bonds.[83]

Five days before the construction contract was signed, on December 15, 1925, tragically, William Beardsley died. He was seventy-five years of age. Since 1892, when he joined his brother George's Agua Fria Construction Company, William Beardsley devoted thirty-three years to the development of the Agua Fria project. It was his only business. Through his obstinacy and cleverness, Beardsley kept the Agua Fria development alive. He managed to sustain the project through bankruptcy, federal restrictions, and legal challenges while remaining seemingly untrammeled throughout the many years of frustration. His son, Robert, who had assisted his father since 1912, now assumed direction of the project, along with Pleasant and the District's other officers.[84]

The sale of the Maricopa Water District's bonds proved more difficult for Pleasant than he had imagined. By March 1926 he had not found a bond house interested in the project. Selling the bonds quickly was important to Pleasant because the construction contract required him to complete the dam, called Frog Tanks, by the end of 1927. As Pleasant soon learned, he could not find a buyer unless he could show that

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[83]It is possible that Beardsley originally intended to pay Pleasant for the construction effort in bonds and not have the Maricopa Water District sell the securities in the open market. Changing the District's name, however, suggests that the District, at least initially, intended to make the sale. Carl Pleasant to the Board of Directors of the Maricopa County Municipal Water Conservation District Number One, March 1, 1926, MWD, Meeting Minutes File; Minutes, Board of Directors, Maricopa County Municipal Water Conservation District Number One, March 3, 1926, MWD, Meeting Minutes File.

[84]The Arizona Republic, December 17, 1925, 5. The newspaper's account stated that Beardsley died in Los Angeles after a four month illness. They did not give the exact cause of death. Beardsley was buried in Middleton, Ohio. Testimony by Robert Beardsley, MWD v. Southwest Cotton, 3551-3552. Robert Beardsley began his involvement in the project soon after he was graduated from Yale University in 1910.

he had obtained a surety bond guaranteeing faithful performance of the construction work. But Pleasant could not contract with a surety company without the monies raised from the sale of the bond issue. Concerned over the urgency to begin work to meet his contractual obligations, Pleasant fortunately found a lending house that was willing to purchase the bond issue. On March 1, 1926, Pleasant wrote to the District's board of directors petitioning them to sell directly and immediately the entire bond issue to the New York City investment firm of Brandon, Gordon and Waddell, known in New York as the "three Scotsmen." Obviously uneasy about the situation, Pleasant frantically wrote to the District's board stating,

> I find it impossible to obtain responsible surety companies who will sign the construction bonds unless assurance is given by me that I shall be able to dispose of the bonds [the District's bonds] for cash as soon as they are delivered, and this means that I obtain a firm contract for their sale with some responsible bond house or houses for the entire issue. Thus it is that I find it impossible to sell the bonds unless I can give the surety bonds for the faithful performance of the contracts to an amount equal to the contract price named in each bond, and I cannot obtain these bonds [surety bonds] unless I shall first make sale of the bonds [District's bonds][85] and this I cannot do unless . . . .

Realizing that Pleasant's recommendation was in its own interests, the District readily approved the sale of the entire bond issue in an agreement with Brandon, Gordon and Waddell on March 3. To ensure its investment, the New York firm sent Donald Ware Waddell to Phoenix to oversee the project. Having already spent several winters vacationing in Phoenix, Waddell was more familiar with the Valley than were his partners Jack Brandon or Alex Gordon. In addition,

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[85]Pleasant must have been naive in accepting bonds as payment. Otherwise his previous construction experience probably would not have led him to accept this arrangement. The construction needed a surety bond in the amount of $1,352,500. Presumably, Brandon, Gordon and Waddell would purchase the District's bonds without requiring a surety bond. Carl Pleasant to the Board of Directors, Maricopa County Municipal Water Conservation District Number One, March 1, 1926, MWD, Meeting Minutes File. The investment firm of Jack Brandon, Alex Gordon and Donald Waddell was located at 120 West Broadway, New York City.

Waddell had come from a farming family coincidentally from the same state as the Beardsley family, Ohio. Although he did not intend to remain in Phoenix for any length of time, Waddell quickly took a personal interest in the project. After a short time, Waddell found himself involved in the daily operation of the District's activities. He soon bought a home and an enormous tract of acreage in the District and moved his wife and daughter from Great Neck, Long Island to Arizona and established the Waddell Ranch. With financing arranged, the construction of Frog Tanks Dam began immediately after the bonding agreement was reached.[86]

Erecting Frog Tanks Dam, completing the diversion dam, and excavating the canal, laterals, and sublaterals began with the establishment of several construction camps. The main camp was erected on the east side of the Agua Fria at the Frog Tanks dam site. Other camps were located at the diversion dam or the Camp Dyer site, and four miles downstream where the canal flume was to be constructed across the river. The main camp was formally designed, with a defined industrial area, community area and living area. In the industrial area all construction facilities were closely aligned and integrated. The construction shops included two blacksmith shops, tool room, machine shop, riggers supply room, nail house, transformer station, concrete plant, hoist and steel tower, garage, supply house, switch and compressor houses, transformer station, cement storage building, water pumping plant, well, and oil storage house. The community area contained a hospital, store, recreation hall, school house, bath houses, and mess hall where dining was segregated between common laborers and engineers and foremen. When construction peaked the living area housed approximately six hundred men. Including wives

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[86]Minutes, Board of Directors, Maricopa County Municipal Water Conservation District Number One, March 3, 1926. The bonds were to be sold for no less than eighty five cents of par value. Payment for the bonds would be received by the District, which would in turn pay Pleasant's construction costs on a monthly basis. Concerning Waddell's interest in the project, Eleanor Libbey, Waddell's daughter, stated that, "my father came from a farming family in Ohio, so it was rather natural through his genes that he'd be interested in this." According to Eleanor Libbey, her father owned at one time 38,000 acres in the District and the Salt River Valley. Waddell remained as a principal leader in the District's organization until his death in 1963. Because of his lengthy association with the Agua Fria project, the Maricopa Water District rededicated Pleasant Dam in honor of Donald Waddell shortly after his death. Interview with Mrs. Eleanor Libbey, 25 November 1986.

and children, the camp may have provided housing for up to one thousand individuals. Single men lived in either tent houses or a bunkhouse. Those men with families lived in framed homes situated apart from the bachelors' quarters. The camp had an electrical, water and sewage system. Carl Pleasant did not live at the camp. He commuted from his home in Phoenix to the construction site every day. Housing and offices, however, were set up for his engineering staff on site.[87]

Work at the diversion dam was a relatively uncomplicated task. Although approximately eighty five percent complete, its crest still remained ten feet below the canal intake. The dam was finished using poured concrete instead of masonry rubble. The top of the dam was formed as a standard weir spillway section for its full length. At its center, two, hand operated sluice gates were constructed through the dam's face. The intake into the canal was fitted with five

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[87]The District's construction contract with Pleasant actually consisted of eighteen specific and separate contracts. Having subcontracted for much of the work, Pleasant only needed to post a surety bond of $72,500. The bond was posted by the Southern Surety Company of Des Moines, Iowa. Southern Surety also posted bond for many of the other subcontracts. Metropolitan Casualty Insurance Company of New York also posted surety bonds. "Construction Contracts and Specifications," MWD, Contracts, Agreements and Specifications File. Most of Pleasant's subcontractors were from Oklahoma with the exception of the Western Construction Company of Delaware. The subcontractors were: J. H. Jenkins; G and B Equipment Company, Tibbets and Pleasant, Inc. (this company belonged to Joe Pleasant, Carl's brother); Green Beekman Construction Company, Garfield County Construction Company and Brooks and Company. Some initial clearing work at the two dam sites and excavation of the canal was begun in 1925. Preparing the construction camps also involved the construction of several sections of roads at the Frog Tanks camp, to Camp Dyers, and to the camp at the river crossing flume. A. E. Rogge and Cindy L. Myers, eds., First Annual Report, Historical Archaeological Investigations at Dam Construction Camps in Central Arizona. (Phoenix: Dames and Moore, November, 1987): 15, 45-48, 50-54. For a map of the Frog Tanks camp see page 15. Carl Pleasant resided at 119 East Coronado in Phoenix.

gates, a sand trap, and two sluice gates to flush silt and other obstructions.[88]

Canal and lateral work involved the excavation of an enormous amount of earth. Only four miles of canal had been excavated in the 1890s and much of that distance had naturally filled in over many years of non-use. In addition to repairing the original work, construction required extending the canal an additional twenty eight miles. As a result, nearly two million cubic yards of material needed to be removed. Various sections along the canal line required different sized flumes, steel and iron pipes, wooden drops, bridges and trestles. The largest component of the canal was a bridged flume used to convey water across the Agua Fria.[89] Completing the canal took several years.

The construction of Frog Tanks Dam presented an enormous challenge to Carl Pleasant. Over fifty separate tasks were required because of the sophistication of the dam's design. Several preliminary activities were required to prepare the site before construction could begin. This work included: clearing and grubbing the site; constructing a 750 foot flume to divert the river; determining, by diamond core drilling, the exact location and elevation of the foundation's heel and toe; excavating to suitable bedrock, free of seams and cracks at the dam and spillway sites; dewatering the foundation; grouting any foundation cavities; and constructing a cutoff trench. Actual construction began after the dam site was prepared. Major construction activities consisted principally of: framing and pouring the buttresses, piers and arches; forming and placing the steel reinforcement; setting the steel penstocks, outlet works, bulkheads and irrigation valve; framing and pouring the spillway and setting the spillway gates and motors; and

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[88]"Specifications," MWD, Contracts, Agreements and Specifications File. The sluice gates were four feet by ten feet.

[89]The canal extended a total of 32.5 miles. The laterals added an additional sixty miles. Excavation included the removal of 1.7 million cubic yards of material. The gravity-flow canal was planned to carry five hundred second feet of water. As it neared its end it narrowed to carry only twenty second feet. The flume crossing the river was constructed of steel and supported by timber trestles. At each section line, laterals were taken off, running east and carrying from one hundred second feet to ten and finally to 7.5 to the sublaterals. "Lake Pleasant Dam, Near Phoenix, Will Be the Highest Multiple Arch Dam in the World," 31, 60.

finishing the dam's crest with face slab, cantilever wall, and parapet walkway.[90]

Pleasant's construction plant layout was automated to convey material from the mixing or batch plant to the buttress and arch forms. After sand and gravel aggregate were screened at the site and Portland cement was delivered to the camp, concrete was prepared in large silos in the batch plant located adjacent to the dam's center line on the east bank of the river. After mixing, the concrete was carried to a placing tower's receiving hopper located near the center of the dam. Concrete was then hoisted by skip to the tower's various chute lines which were positioned above the form work. The wet concrete then flowed by gravity to the different parts of the dam via the chutes. (For construction photos see AZ-11-9 through AZ-11-40.)[91]

Actual construction progressed rapidly after the site had been prepared. Pleasant managed to pour approximately eight thousand cubic yards of concrete per month. In December 1926, Frog Tanks Dam, now named Pleasant Dam, was nearly two-thirds complete. Pleasant would easily meet the following year's construction deadline.[92]

Pleasant Dam was completed in October 1927. Although excavation work continued on the canal for many more months

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[90]Excavation to bedrock required the removal of approximately 80,000 cubic yards of earth. Explosives were used in the work. Specifications for Frog Tanks Dam contained some unusual provisions. "Preservation and Restoration of Property," stated in part, "No trees shall be destroyed without the consent of the Engineer." "Specifications," MWD, Contracts, Agreements and Specifications File.

[91]Under three separate contracts, 108,000 barrels of standard Portland cement were delivered to the construction camp. Sand and gravel aggregate, obtained at the site, amounted to 105,600 cubic yards. Concrete needed for the spillways was probably delivered over a temporary, narrow-gauge rail line. The spillway's location was referred to in the contracts as Chinamen's Gulch.

[92]It appears from the contracts that Carl Pleasant constructed the buttresses and arches from the foundation to slightly above the stream bed elevation. From there, the work was divided. Joe Pleasant worked from the west end to and including buttress number ten. Green and Beekman Construction Company worked from buttress ten to the east end of the dam.

and other minor activities needed to be completed, the Agua Fria project was essentially finished. The Beardsley family, Carl Pleasant, Donald Waddell and the Maricopa Water District had accomplished a formidable achievement. Plans to dedicate officially the dam were set for November 19. Residents of Phoenix were invited to watch actress Gloria Swanson formally christen the structure by breaking a bottle of Arizona grapefruit juice over the dam's crest. An "extensive program of entertainment" was planned, the local press reported, including a "mammoth barbecue."[93]

A week after the dedication of Pleasant Dam was announced, it was postponed until the following February. The reason the District gave for the delay was that it was unable to complete its arrangements for the ceremony. Unfortunately, this was not completely true. Beardsley, Pleasant and Waddell were preoccupied with a more serious problem. Structural problems to the dam's buttresses that had become apparent earlier that year cast doubt on the safety and stability of Pleasant Dam and made the project's entire future uncertain.

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[93] The Arizona Republican, November 7, 1927 and November 13, 1927.

Chapter V, The "Unpleasant Truth About Pleasant Dam"

In the second year of construction, Pleasant Dam was progressing rapidly. By February 1927, nearly all of the buttress foundations had been poured and the dam had risen one hundred feet above the river. Beardsley, Pleasant, and the Maricopa Water District organization were confident that the work would be completed without incident by the coming autumn. Unfortunately, this would not happen. While positioning forms to increase the height of the buttresses, workers began to notice small cracks in the dam's buttress walls. Vertical cracks quickly became visible in most of the buttresses, many extending from ground elevation almost through the entire height of the completed work. The cracks caused a highly controversial debate concerning the dam's safety and the project's completion, challenging the integrity of Pleasant Dam's multiple arch design. Although dismissed by some engineers as minor blemishes, the cracks completely undermined the success the District hoped to enjoy with the completion of the storage work.

Because of the uncertainty of how the cracks affected the safety of the dam, the Maricopa Water District hired Fred A. Noetzli, a leading multiple arch theoretician from California, to analyze the dam's design. After visiting the dam site, Noetzli thought that the cracks unquestionably were the expected and natural result of the concrete shrinking as the structure set and hardened. He was certain of this because the dam had yet to be subject to any water pressure or water load. The cracks could have been prevented, Noetzli believed, if the buttresses had received horizontal steel reinforcement in addition to vertical reinforcement. To minimize the influence of the existing cracks and prevent their further movement, Noetzli recommended to J. G. Tripp, Pleasant's construction foreman, that horizontal steel bars be immediately placed in each uncompleted buttress near the surface of each wall. Tripp did not implement Noetzli's instructions.[94]

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[94]Noetzli attributed the lower winter temperatures to the concrete shrinkage. He further recommended to Tripp that all vertical bars in the buttresses be omitted except those needed for construction, that all inclined bars in the buttresses, downstream twenty feet distant horizontally from the underside of the water slab, be omitted, and that inclined bars be added to certain buttresses, arches and water slabs. Fred A. Noetzli to J. G. Tripp, February 13, 1927, MWD, Reports File. Tripp had previously been working on the construction of Coolidge Dam.

Noetzli made several additional recommendations for Tripp to integrate promptly into the design. He did not find one foot of freeboard to be sufficient for a dam as large as Pleasant. Wave wash over the dam's crest, he feared, could possibly scour the downstream buttress foundations and erode the cutoff wall at the east abutment. He advised lowering the spillway sill and raising both cutoff walls. Noetzli further urged that the arches near the crest of the dam receive added reinforcement and that drainage be provided at the dam's base to relieve potential internal pressure. All these recommendations, except lowering the spillway sill,[95] were incorporated into the final design.

In his final report, submitted to the District in May, Noetzli stated that Pleasant Dam's bold design (actually only a modified version of one of his own) presented structural uncertainties. The design of the top of the dam presented the most significant problem. Unlike other multiple arch dams, Pleasant Dam was designed to cut off the arch barrels below the high water level and to close the dam's crest with a three foot inclined cantilever wall between the arches and the two foot face slab. With the storage level above the crest of the arch barrels and the buttresses, the design finished the support buttresses below the dam's expected storage height or below the height of its full water load. This modification saved a significant amount of concrete because, as has been stated, it reduced the base length of the buttresses in their upstream and downstream direction. However, a shortened buttress base length combined with a storage elevation surpassing the tops of the buttresses, brought additional tension stresses on the buttresses in the upper parts of the dam. The shortened buttresses brought a very high bearing pressure or tension stress from the arch crowns, cantilever wall, and face slab to the buttresses; Noetzli calculated this at about two

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[95]Fred A. Noetzli to J. G. Tripp, February 15, 1927, MWD, Reports File. Freeboard is the distance from the high water mark to the dam's crest. Noetzli recommended lowering the spillway sill by at least two feet and raising the cutoff walls eighteen inches. Reinforcement to the upper portion of the arches could be accomplished by additional concrete or by adding steel reinforcement, or both. Noetzli also suggested that drain holes, openings in the lower part of the partition walls, and a drainage tunnel at the east abutment be added to the construction effort. Noetzli added further that the area of contact between the buttress walls and the water slab be chipped and roughened to provide good bonding, and that the District consider leaving the spillway gates open for the first two years of operation to keep the dam from being subject to full water load.

hundred pounds per square inch. The designers of Pleasant Dam failed to assume these tension stresses. The resulting sliding factor or longitudinal shear in the upper portions of the dam, he considered, was consequently quite great. The presence of cracks in the buttresses only aggravated the situation because they changed the statical condition of the buttresses. Possibly the dam would not act as the monolith it was designed. Noetzli stated that the cracks, therefore, presented a "most serious menace to the safety of the dam." Noetzli believed that the deficiency of the design plan, however, could be overcome. He recommended that the buttresses be strengthened by securing them with horizontal steel ties.[96]

Despite subsequent pleas by Noetzli through the summer, Pleasant did not add the steel ties during the remaining construction period. The District's decision was possibly due to William Davenport's analysis. Davenport, the Santa Fe Railroad engineer who had reviewed the design in 1925, was asked to examine the dam's construction independent of Noetzli. Davenport's comments, forwarded in March 1927, generally were limited to a discussion of the contact point between the arches and buttresses and the kind and amount of reinforcement needed in that area. Davenport mentioned the

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[96]Fred A. Noetzli, "Report on Repairing and Strengthening of the Lake Pleasant Multiple Arch Dam," May 5, 1927, MWD, Reports File. The top of the dam was radically modified, as has been explained, to lessen the quantity of materials and thereby save money. Cutting the arches consequently reduced the height of the buttresses and the material savings was realized in the shortening of the base length of the buttresses. Under the assumption of monolithic action on the arches and buttress walls, Noetzli thought that tension stresses were not considered by the dam designers. Noetzli stated that tension stresses through the various horizontal sections of the dam were not an assumption under the "older methods of design." Under this "older method," Noetzli believed that the design was justified except for the sliding or shear stress. It was not beyond the realm of possibility that the dam would fail, Noetzli stated, if the suitable strengthening of the buttresses was not provided before the reservoir was filled. Steel ties were recommended for buttresses two through twenty inclusive. The ties would be located at various elevations and would be anchored to the buttress walls by holes drilled four feet high by six feet wide. In his final report, Noetzli also made minor suggestions for improving the arches, water slab and dam's crest. Noetzli made all his recommendations based upon the assumption that the foundation was sound.

problem of longitudinal shear in the buttress slabs but made no recommendation similar to Noetzli's placement of steel ties. As he had in 1925, Davenport qualified his remarks by cautioning the District that he was not an "expert on the construction of dams."[97]

In the fall of 1927, the District considered employing another consulting engineer to make a detailed analytical report on the stability of the dam. Its decision was prompted by Davenport's visit to the dam in October. After studying Noetzli's report and viewing the cracks, Davenport told J. G. Bailhache, an engineer employed by the District, that although the cracks weakened the structure, he was not worried about them. He recommended that the cracks be grouted and that if reinforcement was added, the ties be placed parallel to the buttress slabs instead of perpendicularly. Davenport, characteristically cautious, added that his opinions were still preliminary and made without mathematical calculations.[98]

In November the District hired B. F. Jakobsen, another consulting engineer from Los Angeles with a background in multiple arch analysis. Jakobsen was asked to calculate the stresses in Pleasant Dam and compare them to those he had computed for Eastwood's Lake Hodges Dam, another multiple

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[97]On July 16, 1927, Noetzli stated that he trusted that the Maricopa Water District would decide to put in the repair ties so that there would be no question about the safety of the dam and because the cost of the work would be greatly increased if it was done after the present construction plant was dismantled and a new plant, cable way, hoist, and chutes were required later. Fred A. Noetzli to Carl Pleasant, July 16, 1927, MWD, 1920s Construction File. On August 8, 1927, Noetzli wrote again to Pleasant. This time he stated that additional studies with regard to the stresses in the buttresses confirmed his previous conclusion "that the dam cannot be considered safe unless suitable remedies have been taken to offset the effect of the cracks in the buttresses." Fred A. Noetzli to Carl Pleasant, August 8, 1927, MWD, 1920s Construction File; William L. Davenport to C. E. Griggs, March 8, 1927, MWD, 1920s Construction File.

[98]Bailhache accompanied Davenport during his inspection of the dam site. Memo, J. G. Bailhache, October 6, 1927, MWD, 1920s Construction File. Placing the ties parallel, Davenport believed, would be structurally advantageous and easier to construct. Davenport also agreed that all possible data should be collected on the cracks and that they be monitored for movement.

arch that also developed buttress cracks. After devoting many weeks to the problem, Jakobsen stated that the dam was not safe. His conclusion was not empirical but judgmental based upon comparison. The maximum tension stress at Lake Hodges, Jakobsen determined, was seventy pounds per square inch. At Pleasant, Jakobsen computed maximum stress to be three times as great or about what Noetzli had figured. Presumably, this amount of stress was excessive. Since he was not consulted to provide suggestions to repair the dam, he made none. He did, however, reject several alternatives that had already been proposed. Jakobsen did not favor grouting the cracks since he thought they would open further. He rejected Noetzli's recommendation to tie the buttress walls together. Filling the buttresses solid, another alternative under consideration, would also not work because, Jakobsen stated, the tension stresses would still exceed those at Lake Hodges by thirty pounds. The only substantive recommendation Jakobsen made was the somewhat obvious observation that the reservoir should be kept from filling until an appropriate solution could be determined.[99]

Since no clear consensus was reached concerning the stability of Pleasant Dam, rumors that the cracks threatened the safety of the structure developed in 1928. Concerned that its downstream cotton fields were endangered, Southwest Cotton hired Howard S. Reed, a Phoenix engineer, to assess the safety of the dam. Reed wrote to Noetzli and asked him if the "persistent rumor" was true that the dam had developed "some dangerous cracks" and if he had recommended that water should not be impounded until "necessary repairs" had been made. In reply to Reed, Noetzli stated that the District had complied with his

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[99] C. E. Griggs to B. F. Jakobsen, November 30, 1927, MWD, 1920s Construction File. Bernhard Faaborg Jakobsen was partner in the firm La Rue and Jakobsen. Lake Hodges received bracing to its buttresses in the mid 1930s to protect it from seismic activity. See "Hodges Dam Strengthened," Engineering News-Record, (November 5, 1936): 644-647. In the same letter that Jakobsen stated, "I do not believed the Lake Pleasant [Dam] is safe as it stands now," he stated also, "every test I have applied shows the Lake Pleasant Dam to be less safe than those dams I have compared it with." B. F. Jakobsen to C. E. Griggs, January 17, 1928, MWD, 1920s Construction File. Although Jakobsen refuted the idea of filling the buttresses, he did state that the District should consider "adding to the buttresses." He did not say how that should be done. See letters from B. F. Jakobsen to C. E. Griggs dated: January 2, 1928; January 6, 1928; January 7, 1928; January 9, 1928; and January 30, 1928, MWD, 1920s Construction File.

recommendations regarding the use of additional steel reinforcement in completing the tops of the buttresses and therefore he believed that "the rumors about the safety of the dam [were] exaggerated." After receiving Noetzli's assurances and inspecting the dam himself, Reed agreed with Noetzli that the dam was not in immediate danger of failing. On the very same day that Noetzli responded to Reed, he also again wrote to the District's C. E. Griggs, urging him to undertake the addition of the steel ties "so that all anxiety as to the safety of the structure will be removed."[100]

Nevertheless, rumors grew more persistent through the spring when it was discovered that the dam's foundation might be crumbling. It was observed that the dam's drainage system was failing to keep the downstream side of the foundation from becoming soaked. Because the dam's bedrock consisted principally of volcanic tuff deposits, it was feared that excessive seepage would cause the foundation strata to "melt" when it became saturated. Upon learning of the apparent failure of the drainage system, Noetzli wrote to Robert Beardsley stating, "Although I am not connected with the project any more . . . conditions . . . prompts [sic] me to write you this letter and suggest that an investigation be made immediately to preclude the possibility of a disaster."[101]

The doubts raised by the buttress cracks and the condition of the foundation had a definite effect on the project's leadership. The frustration and anxiety caused by the controversy played upon the development's organization causing it to break down. In a letter to Beardsley, District Engineer Griggs detailed the differences of opinion that developed between the Maricopa Water District, Carl Pleasant, and J. G. Tripp, and the problem of determining what corrective measures needed to be taken. Griggs wrote,

> Reference to my rec[ommendation] of Feb. 16th to get out a criminal charge either for libel

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[100]Howard S. Reed to Fred A. Noetzli, February 23, 1928, MWD, 1920s Construction File; Fred A. Noetzli to Howard S. Reed, February 24, 1928, MWD, 1920s Construction File; Fred A. Noetzli to C. E. Griggs, February 24, 1928, MWD, 1920s Construction File; Howard S. Reed to Fred A. Noetzli, February 29, 1928, MWD, 1920s Construction File.

[101]Noetzli learned of the drainage problem from S. A. Kerr, an assistant to Joseph B. Lippincott, an engineer that the District was soon to retain. Fred A. Noetzli to Robert Beardsley, April 24, 1928.

> or negligence against Tripp and Pleasant for their actions and talk concerning the foundations of the dam. I am afraid we have been too ladylike with both gentleman, in not bearing down on them for thier [sic] silly charges and actions. . . . When the first weaknesses showed up in the dam, Pleasant got Noetzli on the job, and then said he would be G__ D___ if he would follow his recommnedations [sic]. We then got Jakobsen to go over the work for us, and nothing practical has yet been done. Kerr has been gone for a month and nothing of a definite nature has been done except to get another engineer on board to go over the proposition. Tripp's threat to go to the Certification Board, if we "bear down on him" has all the earmarks of blackmail . . . . If Tripp and Pleasant have done something during the construction which we know nothing of, and it might make the dam unsafe, for heaven's sake, let us smoke the gentlemen out. They are now both in writing on this subject, and a warrant jerking them up before a court might either make them shut up or, tell what they know if they are holding something back.[102]

After over a year of controversy, the State Certification Committee entered the debate in the summer of 1928. Although the state was uncertain of its regulatory control over the District's project, having already reviewed and approved the dam's design, it decided it would still reevaluate its construction. State Engineer W. C. Lefebvre assigned J. A. Fraps, a young engineer who had been working on the multiple dome Coolidge Dam on the Gila River, to report on the condition of Pleasant Dam.[103]

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[102]Even Pleasant and Tripp did not agree on what measures should be taken. Pleasant thought a drainage tunnel would alleviate the foundation problem while Tripp did not. (Pleasant would later insist that the dam did not need any corrective measures.) Griggs thought that Tripp may have have been motivated in his actions by some "roundabout way to get the $25,000 commission which Pleasant promised him." C. E. Griggs to Robert Beardsley, May 11, 1928, MWD, 1920s Construction File.

[103]Under the 1921 revisions made to the 1919 state water code, the Water Commissioner's authority in regulating the development of an irrigation project after initial

(Footnote Continued)

Fraps' report also concluded that the dam was not safe. He found himself in agreement with Noetzli in two respects. Because of the cracks, Fraps recommended that eight buttresses receive horizontal steel reinforcement. Fraps also recognized that the amount of freeboard at the dam's crest was inadequate. He advised that water not be stored above one hundred and sixty-seven feet above the river bed, or four feet below the top of the dam. Because of the large volume of water that had percolated through the structure's base, Fraps suggested that additional grouting be done under eleven of the arches. To inhibit further saturation of the foundation, Fraps recommended that the sump that had been placed under arch seventeen be maintained and that drained water be tested to determine the nature of suspended particles in the seepage. Fraps believed that the dam was not presently in a safe condition but he felt certain that if his recommendations were implemented, the dam could be made a structure "about which no fears need be entertained."[104]

(Footnote Continued)
approval was unclear. The complete language of the water code regarding this issue is as follows: "The commissioner shall have authority to examine any dam authorized under the provisions of this act, or any ditch, canal obstruction, diversion, or other work during construction; and at the time of such examination or inspection, or thereafter, the Commissioner shall notify in writing the parties constructing or owning such dam or other works, of any addition or alteration which he considers necessary for the security of the work or the safety of the public or of any person or persons residing on or owning land in the vicinity or below such works, or for the safety of their property, even to the extent of requiring the lowering of the water line." The provision was vague where it stated "or thereafter." On January 14, 1929 the state attorney issued an opinion that the water commissioner did have the authority to require changes to an irrigation project after an inspection which he was permitted to conduct at any time. Act to Amend Sections . . . of Chapter 164, Laws of Arizona, 1919, Known as the State Water Code, March 9, 1921, Session Laws of Arizona 1921, Regular Session (Phoenix, The Manufacturing Stationers, Inc.), 118, 127-128; Attorney General to Frank Trott, January 14, 1929, MWD, ADWR Waddell Dam 1925-1930 File; W. C. Lefebvre to J. B. Lippincott, July 21, 1928, MWD, 1920s Construction File; Robert Beardsley to J. B. Lippincott, August 2, 1928, MWD, 1920s Construction File.

[104]J. A. Fraps, "Report on Waddell Dam," August 22, 1928, MWD, Reports File. Fraps computed maximum tensile
(Footnote Continued)

After Lefebvre reviewed Fraps' report, he promptly wrote Beardsley urging him and the District to incorporate Fraps' conclusions into the dam. Lefebvre defended his petition to Beardsley by stating that the Certification Committee was justified in forwarding its recommendations since significant alterations to the dam's design were made after approval for construction was granted by the board. Lefebvre could not have been more explicit in recommending that the District modify the dam. He wrote, "The Board can not stress too emphatically that, in its opinion, prompt action is imperative in order to insure the safety of the structure before any large volume of water is stored behind the Dam."[105]

Before Fraps' report was ordered, the District management had been considering undertaking another investigation. Lefebvre's letter nearly made their decision for them. The District now hired a team of hydrologic experts consisting of consulting engineers Joseph B. Lippincott and D. C. Henny, and geologist F. L. Ransome. Like Noetzli and Jakobsen, these men had national reputations.[106]

In December 1928, Lippincott, Henny, and Ransome issued their report. After examining Pleasant Dam's foundation characteristics, its design, the cracks, the amount of freeboard, the foundation pumping and grouting, and computing the river's flow and spillway discharge, the three men reached several disturbing and confusing conclusions. The cracks, they said, presented a "serious danger" to the dam's ability to withstand the anticipated high tensile

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(Footnote Continued)
stresses on the buttresses to be 193 pounds per square inch, or approximately what Noetzli and Jakobsen had computed. Fraps recommended that eight buttresses be reinforced and not nineteen as Noetzli had recommended. Apparently, a small leak in arch five had developed and Fraps recommended that the leak be grouted.

[105]W. C. Lefebvre to Robert Beardsley, September 1, 1928, MWD, 1920s Construction File.

[106]J. B. Lippincott to Robert Beardsley, June 13, 1928, MWD, 1920s Construction File; Robert Beardsley to J. B. Lippincott, August 2, 1928, MWD, 1920s Construction File; S. A. Kerr to J. G. Tripp, November 2, 1928, MWD, 1920s Construction File; Robert Beardsley to J. B. Lippincott, December 15, 1928, MWD, 1920s Construction File. Lippincott and Henny, formerly Reclamation Service engineers, were consulting engineers from Los Angeles and Portland respectively. Ransome was a geology professor from the California Institute of Technology in Pasadena.

stresses. They did not recommend repair ties but suggested for "consideration" that holes be cut across the cracks and refilled with reinforced concrete or a combination of cast iron, or steel, and concrete. Despite providing this method to remedy the problem, in the report's conclusion, Lippincott, Henny and Ransome still stated "That even with complete success in remedying [the] cracks the dam will not have the degree of safety which boty [sic] your interest and that of the public demand."[107]

Lippincott, Henny, and Ransome's findings concerning water storage and releases were even more problematic. After reviewing stream flow records and determining the dam's spillway capacity, which they computed to be 117,000 cubic feet per second, twelve thousand more than originally calculated, the report added a new deficiency to the dam's design. Pleasant Dam now had an inadequate spillway to pass maximum flood waters which were calculated at 157,000 second feet. In the event of flood, the three men concluded, the dam could not resist overflow. They recommended that another spillway, west of the present one, be built and its sill be placed twenty-four feet below the present spillway sill, or at elevation 130 feet above stream bed. Under the new spillway, the report stated that the reservoir would remain eleven feet below the top of the dam during a peak flood.[108]

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[107]The report found the foundation to be fairly satisfactory. Ransome wrote, "As a whole, the tuff has sufficient hardness, durability and resistance to water to constitute a fairly good foundation rock." Draining the tuff under the buttresses, Ransome believed was not necessary. Ransome did conclude that because of the irregularity in the distribution of the volcanic formations, it was "impossible" for him to determine the "precise character of the foundation." The report also did not see the need for additional grouting and did not believe that the amount of percolation was dangerous. The report computed about the same maximum tensile stresses as previous reports, or about two hundred pounds per square inch. J. B. Lippincott, D. C. Henny and F. L. Ransome, "Report on Lake Pleasant Dam," December 17, 1928, MWD, Reports File.

[108]The greatest recorded flow to that date on the Agua Fria River had occurred in 1916 when flood waters were measured at 105,000 second feet. The spillway capacity was obviously based on this measurement. Cost for the new spillway was estimated at approximately $600,000 and would require excavating approximately 600,000 cubic yards of earth. Money could be saved if the present spillway gates

(Footnote Continued)

Lippincott, Henny, and Ransome would not say at what level water could be safely stored behind the dam. They realized that the dam had already safely resisted a water load of 117 feet, the amount of water that had accumulated in the reservoir. They did say that the dam was "probably safe" at a reservoir elevation of 130 feet, and that it was "possibly" safe at a reservoir elevation of 154 feet, or to the base of the existing spillway. They did not believe that water should be stored to one foot below the dam's crest because of the potential for erosion at the downstream toe due to wave wash.[109]

Although District engineer Frank F. DeMerse objected to the recommendations made in the Lippincott, Henny and Ransome report, Beardsley decided that the District should not permit water to rise in the reservoir above 130 feet. This precaution could not be maintained realistically since the irrigation outlet valve at the base of the dam was too small to maintain the water level in the reservoir at that elevation in the event of any significant inflow. State Engineer Lefebvre's successor, William W. Lane, agreed with the District's plan, however feeble, and convinced the State Water Commissioner, Frank P. Trott, of the plan's value. Trott, however, officially ordered on December 31, 1928, using the state water code as his authority, that "under no condition" was the District to permit water in the reservoir to rise above 130 feet.[110]

The Pleasant Dam controversy peaked in January 1929. On January 4, the Maricopa County Board of Supervisors met to discuss the condition of Pleasant Dam. The board convened

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(Footnote Continued)
were moved to the new spillway. Storage capacity would be reduced under the new spillway from 173,000 acre feet to 125,000 acre feet.

[109]It appears that Ransome objected to some of the report's conclusions made by Lippincott and Henny and did not sign the report.

[110]DeMerse thought that the cracks would continue to expand and contract due to temperature and any concrete placed in the holes consequently would not work. DeMerse also thought that there were less expensive ways to obtain increased spillway capacity. He suggested raising the dam's parapet wall which would increase the spillway's capacity to 150,000 second feet. Frank F. DeMerse to the Board of Directors, Maricopa Water District, December 29, 1928, MWD, 1920s Construction File, and MWD, ADWR Waddell Dam 1925-1930 File. Frank P. Trott to George W. P. Hunt, December 3, 1928, MWD, 1920s Construction File.

at the behest of the Salt River Valley Water Users' Association to discuss two issues: Did it have the legal authority to take any action concerning Pleasant Dam independent of Water Commissioner Trott's authority? If it did, what course should it take? These items quickly became secondary, however, as the meeting developed into a heated debate between Frank Reid, president of the Salt River Valley Water Users' Association, C. C. Cragin, General Superintendent and Chief Engineer of the Water Users', and Carl Pleasant.[111]

Making their position very clear at the outset of the meeting, Reid spoke first stating, "It seems to me we [the Board of Supervisors] should undertake to organize ourselves into a body which would provide funds to do the things which should be done immediately." Reid and John L. Gust, the Water Users' attorney, believed that the county board had the legal authority to conduct actions to make Pleasant Dam safe. Reid argued that the "board of supervisors . . . is the only official body in this county which has to do with a situation of this kind." Reid wanted safety measures taken because he believed Pleasant Dam posed an immediate danger to the community.[112]

C. C. Cragin supported the Water Users' petition by presenting to the county board the previous studies which questioned the stability of Pleasant Dam. Cragin concluded that the dam was unsafe because he believed "no one can tell just what the present safety of factor is . . . ." Cragin stated that if Pleasant Dam failed it would cause property damage up to $50 million and cause the deaths of "hundreds to many thousands." Flooding would damage the Yuma Project downstream and destroy irrigation works in California and Mexico for which the State of Arizona would be liable. Cragin thought that the quickest and safest way to make the dam safe would be to drill three, twenty by forty foot openings at the bottom of the dam to insure that water would not rise above Trott's order to limit water storage elevation to 130 feet.[113]

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[111]"Proceedings Before the Board of Supervisors of the Maricopa County in Re Lake Pleasant Dam, January 4, 1929," Salt River Project Research Archives.

[112]Robert Beardsley testified that he had only heard of the board's meeting the day before. "Proceedings Before the Board of Supervisors," 1, 16, 20, 44.

[113]"Proceedings Before the Board of Supervisors," 7-10.

Pleasant completely disagreed with Reid and Cragin. He argued that the dam's existing spillway was adequate and that the stresses exerted against the dam were not dangerous, or at least no more dangerous than at Cave Creek Dam, the multiple arch dam that the Water Users' helped fund. Pleasant could not have been more vigorous in his defense. He said that Reid and Cragin were grossly unfair in their attack of the Agua Fria project because they could not criticize Pleasant Dam without finding fault with their own Roosevelt, Horse Mesa, Mormon Flat, and Cave Creek dams. Using language from his athletic collegiate days, Pleasant said he was ready to "go to the mat any time" in defending the Agua Fria project.[114]

Pleasant argued that the dam's spillway was adequate because the maximum recorded flood on the Agua Fria River was estimated at 105,000 cubic feet per second (cfs). According to the Lippincott, Henny and Ransome report, Pleasant's spillway had a capacity of 117,000 cfs, sufficient size to safely pass maximum flood waters. The largest recorded flood on the Salt River was estimated at 200,000 cfs. Roosevelt Dam's spillway's could only pass 85,000 cfs. At Cave Creek, the maximum spillway capacity was 12,000 cfs while the flood capacity of the wash was 35,000 cfs. In light of these comparisons, Pleasant stated that if Pleasant Dam was unsafe, than Roosevelt and Cave Creek were unsafe as well.[115]

Pleasant also refuted the Water Users' attack on the tension stresses and buttress cracks on the dam. Using the same comparative analysis, Pleasant stated that the tension stresses on Cave Creek Dam were up to 400 pounds per square inch. Tension stresses at Pleasant Dam were less by half. The cracks in Pleasant Dam, the contractor stated, were clearly temperature cracks. They were the result of contraction, "like you find in a piece of pavement." They were not the result of water load. Although the opinion existed that the cracks needed to be corrected, Pleasant stated that "higher technical opinion," presumably Davenport's, stated that the cracks did not need any treatment.[116]

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[114]"Proceedings Before the Board of Supervisors," 18.

[115]"Proceedings Before the Board of Supervisors," 23-27, 31.

[116]"Proceedings Before the Board of Supervisors," 28, 30-32.

Pleasant argued that his points were not merely his "opinion," they were "just arithmetic." Pleasant stubbornly refused to accept criticism of the dam. He reasoned that the criteria used by Reid and Cragin against Pleasant Dam could be equally and more damagingly applied to the Water Users' dams. Pleasant made his point best by responding to an analogy made by one of the county board members. Irritated that Pleasant persisted in making comparisons because when the county board's meeting was being held to discuss specifically Pleasant Dam, the board member stated, "just because one house in Phoenix is going to fall in is no reason why all the houses are going to fall in." Pleasant aptly responded, "Well, you wont [sic] blow down my house without examining your own."[117]

Reid and Cragin defended the Water Users' dams by stating that D. C. Henny had recently found the Salt River Project's storage works safe after a thorough examination. Cragin said if Pleasant Dam overtops, "it is gone." He said, "It is not like Roosevelt, it is not like Mormon Flat, and it is not like Horse Mesa. All of these dams, will stand a great overtopping." Cragin also asserted that Pleasant "doesn't [sic] know anything about the Cave Creek Dam." If cracks did appear in Cave Creek, Cragin said he would be the "first one to come in and ask to blow holes in it."[118]

The day's hearing concluded with a resolution stating that if Water Commissioner Trott determined that Pleasant Dam poses a threat to the life and property of the Valley, then the county board would be willing to take action "at any minute."[119] The resolution was adopted.

The county board reconvened the following day. Again Reid lead the discussion by stating that the Water Users', Central Arizona Light and Power Company (CALAPCO), Southern Pacific and Santa Fe railroads, Southwest Cotton, and the Mountain States Telephone and Telegraph Company had all agreed to contribute a total of $70,000 to Water

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[117]"Proceedings Before the Board of Supervisors," 54-56.

[118]"Proceedings Before the Board of Supervisors," 36-53.

[119]"Proceedings Before the Board of Supervisors," 94-96, 103. In the fall session of the state legislature, a bill was proposed, called the Joyner Resolution, which Cragin described was to allocate funding to "eliminate that [Pleasant Dam] particular menace." The resolution was not adopted.

Commissioner Trott so that he could carry out any emergency measures he thought needed at Pleasant Dam. Reid also suggested that a board of engineers, composed of representatives from all interested parties, be organized to work with Trott to maintain the reservoir's storage elevation at one hundred and thirty feet and to determine how to make Pleasant Dam safe.[120] Frank Reid was voted chairman of the committee.

Although Pleasant agreed to the formation of the committee and even seconded the motion to appoint Reid as chairman, he still insisted that any investigation include a study of all dams in the Valley. When Reid offered another resolution offering to recommend to Trott that he appoint a board of engineers to study Pleasant Dam and act on its conclusions, the discussion became very intense. Pleasant did not object to the resolution but wanted the board to make its study of Pleasant Dam in light of all dams. Pleasant challenged Reid and Cragin to meet the following week to discuss Pleasant Dam and Roosevelt, Horse Mesa, Mormon Flat and Cave Creek dams. If the Water Users' would not meet under these conditions then Pleasant said they were "mental cowards." Pleasant also objected to Reid's selection of who should make up the engineering board because he stated, "to offer that suggestion [board membership] to the Commissioner is equivalent to suggesting to the court who the members of a jury ought to be." Reid agreed to meet the following week to discuss all dams but refused to concede determining membership of the board of engineers. With the motion to establish a board of selected engineers approved, over Pleasant's objection, the Board of Supervisors adjourned for the morning and agreed to present its recommendations to Commissioner Trott that afternoon.[121]

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[120]As Reid stated, "These people [those organizations listed] have advised me they are already to come in and make up a fund to go with funds subscribed by the Board of Supervisors to furnish the Water Commissioner the sinews of war to go ahead with any order that he might issue . . . ." Reid's committee was made up of individuals from the Water Users', Santa Fe and Southern Pacific railroads, Mountain States Telephone, CALAPCO, MWD, Romola Incorporated, a large land holder in the District, Roosevelt Irrigation District, a downstream groundwater user, and Southwest Cotton. "Proceedings Before the Board of Supervisors," 104-108, 141-142.

[121]"Proceedings Before the Board of Supervisors," 118-146. Resolutions one and two are located in MWD, ADWR Waddell Dam 1925-1930 File.

That same day, January 5, 1929, the Pleasant Dam controversy moved to the state capitol. The Arizona legislature held a joint special session hearing to determine the condition of Pleasant Dam. The legislators' hearing lasted four days. Testimony was taken from Beardsley, Pleasant, Reid, Cragin, Lippincott, Henny, Fraps, Trott, Lane, and several others including representatives from Southwest Cotton.[122]

Frustration was reached in the first day of the proceeding. After the committee learned from State Engineer Lane that the laws governing the State Certification Committee now appeared inadequate in ensuring the safe construction of storage dams, senator Alpheus H. Favor asked Lane to detail the condition of Pleasant Dam. Lane said that, although the dam was in "a serious condition," it was not in "immediate danger." Baffled by Lane's sophism, Favor plainly summed up the thoughts of the committee members by stating,

> You must understand we are all laymen. We don't understand these reports. Now, we will ask you to tell us what your report is. You say it is in serious condition and yet not immediately dangerous, and you say still it must in the future have something done to it. Now just what do you mean by all of this?[123]

Under questioning, the engineers provided varied answers to the same questions. Lippincott stated that the water level behind the reservoir should be kept no higher than 130 feet even though he stated that the computations he made did not show that the dam would fail even with water standing at the existing spillway crest, or at 170 feet. Lippincott justified his comments by stating that the means of determining the safety of the dam was not entirely agreed upon among engineers. With water above 130 feet, Lippincott stated, "There is some uncertainty but, as I say, again

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[122]Testimony was taken by: Robert Beardsley; J. B. Button, Superintendent of State Banks; Joseph Fraps; C. E. Griggs; D. C. Henny; W. W. Lane; J. B. Lippincott; J. R. Moore, Southwest Cotton attorney; F. R. McPherson, Southwest Cotton engineer; Thomas Maddock, former State Engineer; Carl Pleasant; Frank Reid; and Frank Trott. The special session was made up of senators A. H. Favor and W. C. Joyner, and representatives B. H. Gibbs, W. S. Norviel and N. F. Murphy. "Report of Joint Committee Appointed by the Senate and House Pursuant to Senate Concurrent Resolution Number 1 of the Sixth Special Session of the Eighth Legislature," January 12, 1929, Salt River Project Research Archives.

[123]"Report of Joint Committee," 10-41.

reserving my right to change my mind, I personally don't believe that [the] dam would go out if the water goes to an elevation of 154 feet." Lippincott still thought it "absolutely essential that the buttresses be "strenthened [sic] in a heroic way" at the earliest possible date. Lippincott was only certain that, if the dam did fail, the fear that Phoenix would be flooded was unjustified since the entire Valley sloped to the southwest, away from Phoenix.[124]

D. C. Henny's testimony, although no more convincing than Lippincott's, was perhaps more lucid. Henny agreed with Lippincott that it was difficult if not impossible to state at what storage elevation the dam became unsafe. He believed that "no two engineers would answer [the] question alike," if at all because, as he reasoned, it was unreasonable to assume that, "if the dam with water at 130 feet is safe, that it is not possible at 131 feet it should suddenly become dangerous." In defense of the dam's design, Henny agreed that though the design was "bold," the necessity for horizontal steel in the buttresses of multiple arch dams had only become "apparent during the last few years."[125]

Carl Pleasant, Frank Reid and C. C. Cragin's testimonies were essentially a continuation of their argument from the County Board of Supervisors meeting. Pleasant again repeated his belief that the dam was structurally sound, and that the debate over the dam's safety was initiated because certain parochial interests opposed the District's development. Pleasant charged that a conspiracy against the Agua Fria project had been created by the Salt River Valley Water Users' Association, the Southwest Cotton Company and the Paradise Verde Irrigation District. Pleasant testified that the Paradise Verde District informed an associate of Pleasant's that if the Maricopa Water District did not reverse its policy towards them, a policy he did not explain, Paradise Verde would:

> attack us by fair means or foul; that [they] would attack us in every way they knew how; that [they] had the newspapers and the Water Users' Association and other civic bodies with [them]; that they would allege that our dam was unsafe and give that all the harmful

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[124]"Report of Joint Committee," 177-202.

[125]Henny believed water should be kept no higher than 130 feet but admitted that it "probably" could safely store water to 154 feet above stream bed. "Report of Joint Committee," 224-258.

publicity that they knew how to give it.[126]

Pleasant added that his associate was told that "you are going to do what we ask you to, because if you don't we will ruin you and everybody connected with you."[127]

Pleasant then went beyond the statements he made at the Maricopa County Supervisor's hearing against Water Users' president Frank Reid. Pleasant now charged that Reid opposed the District's development because he had a personal interest in seeing the Agua Fria project fail. Pleasant stated that Reid owned a large tract of land below the District within the Roosevelt Irrigation District. Reid therefore desired, Pleasant argued, that the dam be breached so that he could obtain flow rights to the Agua Fria River.

Pleasant again attacked Cragin's criticisms using the same comparative analysis he had used at the Board of Supervisors meeting. Pleasant argued that Pleasant Dam's spillway "is the largest in proportion of any spillway on any major stream in Arizona." He repeated his statements concerning the tension stresses at the dam compared to those at Cave Creek. In light of all the evidence, he did not comprehend how the District's dam was, as he sarcastically stated, "going to fall down and strew dead bodies up and down the River . . . ."[128]

Reid informed the joint session that, under the County Board of Supervisors, he had just formed a board of engineers to investigate Pleasant Dam and put into effect any solution that his board and Water Commissioner Trott would work out. Reid added that this examination would be accomplished without any expense to Trott's office because the organizations comprising Reid's board were willing to contribute $70,000 to carry out any recommendations made to remedy the situation. Reid stated that he was willing to start the board of engineer's examination of Pleasant Dam immediately, the next day if possible, because if Pleasant Dam failed, four or five thousand members of the Water Users' would be in the flood path with property valued at ten to twenty million dollars.[129]

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[126]"Report of Joint Committee," 182-202. See also "Proceedings Before the Board of Supervisors," 21-22.

[127]"Report of Joint Committee," 182.

[128]"Report of Joint Committee," 196.

[129]"Report of Joint Committee," 82-86, 142-153.

Of all the witnesses called, the only one to testify with conviction was Thomas Maddock, a former State Engineer who was presently employed by Donald Waddell. Maddock had previous experience with the multiple arch design while he was State Engineer. During his tenure in the early 1920s he approved Eastwood's design of Cave Creek Dam. Like Pleasant Dam, Cave Creek's multiple arch design was strenuously attacked. S. M. Cotton, Assistant Engineer for the City of Phoenix, had vehemently opposed the construction of Cave Creek.

Although he had no previous experience in multiple arch design, Cotton claimed that the Cave Creek design would put the city of Phoenix in "grave peril," and that its failure was "virtually certain." Cotton calculated that the dam's principle fault was that its buttress sections were exposed to tremendous horizontal shear stresses which he computed at well over two hundred pounds per square inch. He believed working stress for shear should not exceed forty pounds. Consequently, Cotton argued that Eastwood's design was "based on ignorance of and contempt for, all the laws of structural science, and is an engineering monstrosity of great menace. It cannot be rationally modified; it would [should] be absolutely abandoned."[130]

Cotton's criticisms of Cave Creek were motivated by his personal interest to design another dam at the Cave Creek site. His objections received initial support but were eventually dismissed when it was shown that his calculations concerning the buttress stresses, as Cragin stated, "contained some very palpable errors."[131]

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[130]Cotton claimed that A. L. Harris objected to the design along with L. B. Hitchcock, former city engineer, and Sheldon K. Baker, consulting engineer of Phoenix. S. M. Cotton to Thomas Maddock, chairman of the Cave Creek Flood Control Board, July 3, 1922, S. M. Cotton Report on Inadequacy of Dam File, files of the Project Secretary's Office, Box 201-88, Salt River Project Records Management Center. See also correspondence contained in Construction of Dam File, files of the Project Secretary's Office, also Records Management Center Box 201-83. For more on the Cave Creek controversy, see Jackson, "A History of Water in the American West," 640-643.

[131]Cotton had suggested to the Phoenix city manager that he had "in mind a dam design for Cave Creek, which appears feasible and would certainly be very economical." C. C. Cragin to Fred Noetzli, July 22, 1922, Construction of Dam File, files of the Project Secretary's Office; C. C.

(Footnote Continued)

Having had to umpire the Cave Creek dispute as State Engineer seven years earlier, Maddock was familiar with the complexities of multiple arch design. The years that had passed since the Cave Creek Dam dispute had only reinforced his confidence in the design. When the special session finally called Maddock to the stand as the last person to testify, his ideas about the multiple arch were clearly formed. He was an overt proponent of the design and certain of its soundness.

Maddock agreed with Pleasant that there was nothing wrong with Pleasant Dam. The cracks, Maddock explained, were "expected," "natural," and "inevitable." The buttresses, he said, had to crack. They were, he said, nothing to become "terrorized" about. "There is nothing out there now," he stated, that "would scare the ordinary engineer." Maddock echoed Pleasant's remarks by reminding the audience that cracks had appeared in several dams. He named Roosevelt, Elephant Butte, Shaver Lake, Bull Run, Lake Spaulding and Mulholland dams as examples. At San Gabriel Dam, then under construction, Maddock reported that artificial cracks actually were being designed into the dam so that it would crack "where they want it to."[132] Maddock thought the spillway was "plenty large enough,"

With Maddock's comments added to the record, members of the joint session drew their conclusions. Unable or unwilling to decipher the varying testimony, the legislators avoided making any specific recommendations concerning Pleasant Dam. They only advised the following: that the State Certification Committee be reorganized to consist of the Water Commissioner, State Engineer and the State Treasurer; that the Committee employ a consulting engineer to evaluate proposed irrigation plans; that the Committee be permitted to assign an engineer to any project during the course of its construction; and that bonds issued for irrigation projects meet certain requirements. The legislature also recommended that the Water Commissioner have the authority

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[132]"Report of Joint Committee," 264-279. Maddock served as state engineer for over four years. Maddock also thought that the amount of freeboard was "immaterial" because the spillway gates could control water within seventeen feet of the top of the dam. Maddock thought cutting a hole at the base of the dam to ensure a certain storage elevation was a "poor one." Maddock concluded that Pleasant Dam was as secure as the recently completed Tempe bridge.

and finances to ensure that water projects are safe even if it meant regulating water storage.[133]

The Maricopa County Board of Supervisors and the joint special session hearings did not solve the Pleasant Dam controversy. The fate of the project still resided in the Water Commissioner's office. The hearings did, however, significantly heighten the debate. Because the Pleasant Dam dispute had persisted unresolved for so long, it now became presumed that the dam was unsound. With no alternatives, Trott appointed a board of engineers to examine the dam. Trott's team was made up of Lippincott, Cragin, Pleasant, and others, or essentially those individuals Reid had already assembled. The engineers were assigned to consider four factors: the structural and hydrographic conditions of the dam and river; the probable damage in the event of a failure; the financial status of the District; and the best method of holding the reservoir at the safest elevation determined. After considering each committees' report, the board collectively reached several final recommendations on January 15, 1929.

The board of engineers determined that, since the dam was not safe to store water to the spillway crest, and since the irrigation release valve at the base of the dam was inadequate to regulate storage, the spillway should be lowered twenty-four feet to one hundred and thirty feet above the river bottom. The cost in lowering the spillway or removing approximately ninety-five thousand cubic yards of material, the board estimated at $125,000. The board's recommendations were signed by all; including Pleasant and Maddock who signed with reservations and objections.[134]

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[133]"Report of Joint Committee," 12-14. The legislature issued its recommendations on January 12.

[134]Members of Trott's committee were: William W. Lane; D. C. Henny; J. B. Lippincott; C. C. Cragin; Carl Pleasant; Thomas Maddock; W. H. Kirkbridge from Southern Pacific; Earl H. Parker from the state water commissioner's office; George L. Davenport; J. R. Iakisch from the Department of the Interior; George G. Easton from the Roosevelt Irrigation District; W. H. Code from Quinton, Code and Hill, consultants for Southwest Cotton; and Barney R. Hodgins from Maricopa County. Committee one, consisting of Davenport, Pleasant, Henny and Cragin, examined the structural conditions of the dam; committee two, consisting of Lippincott and Iakisch, determined the river's hydrographic conditions; committee three, consisting of Code, Easton and Hodgins, considered the probable damage from a failure of

(Footnote Continued)

After two years of inconclusive examinations and hearings, the Pleasant Dam debate had only grown increasingly more intense. Some action, many felt, had to be taken. If not, it was feared that the St. Francis Dam failure, which killed four hundred people in California one year earlier, would be repeated in Phoenix. References were made to the St. Francis disaster despite the fact that the St. Francis Dam employed a mass concrete, gravity design.[135]

Based on the board's recommendations, and premising his authority on the state water code, Trott ordered that Pleasant Dam's spillway be lowered twenty-four feet to ensure that water be kept below the spillway crest elevation. Pleasant, Beardsley and the District did not object. Since neither the state nor the District had funds to perform the work, the money that Reid had promised during the County Supervisors' hearing was used to begin the excavation. Work to lower a fifty foot wide section of the spillway twenty-four feet was begun by the construction company Sharp and Fellows after an agreement was reached with the state on January 26, 1929. One month later the Arizona legislature appropriated $175,000 to complete the work.[136] (See photos AZ-11-41 and AZ-11-42.)

(Footnote Continued)
Pleasant Dam; and committee four, consisting of Kirkbridge, Maddock and Parker, assessed the economic conditions of the District and the best method to hold the reservoir elevation below the recommended height as determined by committee one. Board of Engineers to Frank P. Trott, January 9, 1929, MWD, 1920s Construction File; W. W. Lane to Frank Trott, January 12, 1929, MWD, 1920s Construction File; "To the Main Committee on Lake Pleasant Storage Works," nd, MWD, 1920s Construction File; Committee of Thirteen to Frank Trott, January 15, 1929, MWD, 1920s Construction File. The team of engineers also concluded that storage of the reservoir to elevation one hundred and thirty feet would provide enough water to irrigate the approximately nineteen thousand acres that were presently under cultivation in the District. If the dam should fail, the team estimated that 57,000 acres of cultivated land would be inundated and the loss of life and property would be "very large." Pleasant and Maddock's objections were not detailed.

[135]For an account of the St. Francis failure, see Charles F. Outland, Man-Made Disaster, The Story of St. Francis Dam, (Glendale, California: The Arthur H. Clark Company, 1963).

[136]Agreement Between Frank P. Trott and the Sharp and Fellows Contracting Company, January 26, 1929, MWD, 1920s
(Footnote Continued)

For the state, the special session hearing and Trott's ruling culminated in the passage of two new state laws concerning dam safety. The State Board of Reservoir Control and Supervision was created on February 21, 1929. The members of Reservoir Control Board consisted of the Governor, the State Engineer, the State Water Commissioner, and a member selected from the state tax and the state industrial commissions. The Control Board was authorized to determine if the "existing or anticipated condition of any dam" was or might become a menace to life and property. If the Board determined that a dam was a menace, then the Board was authorized to abate the threat by any method the situation might require "as far as is consistent with the protection of life and property." On March 22, 1929, the state legislature passed another bill providing for the State's Supervision and Regulation of Dams Act. This act transferred general authority in overseeing the construction and maintenance of dams in the state to the State Engineer. The law also stated that failure to comply with the provisions of the act constituted a felony.[137]

(Footnote Continued)
Construction File. Sharp and Fellows had previous dealings with Lippincott which may explain why they received the contract. The initial plan to make the spillway cut fifty feet wide was changed to 175 feet in width. The spillway cut reduced storage capacity to 73,000 acre feet or well over half. Since capacity was so diminished, the state constructed a ten-foot high earthen dike across the spillway to increase capacity to 91,000 acre feet. The dike could be easily washed away in the event of flood. The dike, however, leaked excessively and consequently added little to the reservoir's storage capacity. The District proposed to erect a concrete gravity structure in the spillway to increase storage to 95,000 acre feet but this was not done. Beardsley to T. S. O'Connell, April 29, 1931, MWD, Construction File.

[137]The $175,000 allocated for the spillway excavation at Pleasant Dam was authorized under the Board of Reservoir Control Act. Previously, failure to comply with the State Certification Committee in constructing a water storage system constituted a misdemeanor. Legislators thought that violations should have more serious consequences and therefore made them a felony under the March Supervision and Regulation of Dams Act. Act Creating Board of Reservoir Control and Supervision, February 21, 1929, and Act Providing for the Supervision and Regulation of Dams, March 22, 1929, 1929 Session Laws of Arizona, Regular Session (The Arizona Printers, 1929), 35-41, 332-345.

The difficulty in determining Pleasant Dam's safety was based upon how the cracks affected the dam's ability to resist the reservoir's expected water load. That the cracks were the result of temperature changes incurred during the curing process was somewhat moot since how they occurred was not as important as what effect they had on the dam's ability to carry the water load. But what effect the cracks had on the dam, if any, could not be easily or definitively answered. It was not that engineering practice exceeded engineering science in the construction of Pleasant Dam. Rather, the over-dependence on theory to provide exact answers where they could not be thoroughly given caused the dilemma.

Were the design assumptions inherently inadequate? Did the shortened buttress lengths cause excessive shear stresses at the higher horizontal sections of the buttresses, or more importantly perhaps, what amount of stress was excessive? Was the water load carried completely by the buttresses and the arches or by the buttresses alone? Did the cracks threaten the design to the extent that the structure did not act as a monolith and was that even important? Did the cracks cause the arches and buttresses to act independently? Did the failure to assume principal tensile stress make the design unsafe, and what method of analysis was accurate and appropriate in determining principal stresses? Since there were no unequivocal answers to these questions, any analysis could reach a different conclusion - which they did. Davenport said the structure was sound but always qualified his assessments by maintaining that he was not an expert in the subject. Jakobsen said the dam was unsafe only because he considered it was less safe than Lake Hodges Dam. Lippincott, Henny and Ransome seemed to doubt if the dam could ever be made safe. Lippincott, speaking independently, would say that the dam was unsafe, but only if he could reserve the right to change his mind. Cragin said the dam was unsafe simply because no one could determine the desired safety factor. These answers were not wrong. They only proved that the dam's stability could not be evaluated with axiomatic certainty.

The failure to trust Pleasant's multiple arch design resulted from a misunderstanding of the relationship between science and technology. It was false to assume that Pleasant Dam was constructed by using technology that was completely driven by previous scientific discovery. The dam's construction was not simply an instance of applied science. Quite the opposite was true. The dam's design was invented, not discovered. Its physical form was innovative and artificial, not predetermined. Consequently, mathematical calculation could only support the design's plausibility or its probability for success. It could not prove it conclusively. It could not guarantee it.

Because technology's underpinnings are not completely based on the immutable laws of science, they do not necessarily follow any scientific imperatives. A design hypothesis does not result from simply applying certain criteria leading to one optimal solution. Technological development alone, therefore, can not dictate or control events. More is required for it to succeed than demonstrating that it has a basis in rational, scientific elements. Technology then also has a political component. The use of technological development consequently becomes subservient to the political forces that control and manipulate it.

Since Pleasant Dam's stability could not be confidently assessed by the professional community, the Agua Fria project became open to wider evaluation and criticism. The Water Users' under Reid and Cragin might justly argue that Pleasant Dam could pose a threat to the downstream Water Users' lands because there was no consensus of opinion concerning the stability of the dam. However, their motivations may have also been "unfair," as Pleasant charged.

Beyond the valuable comparisons Pleasant drew between his dam and those of the Water Users, other factors point to the Water Users' prejudice. As Pleasant stated, Frank Reid, did in fact, have a large real estate interest downstream from the Agua Fria project in the Roosevelt Irrigation District. He would certainly have benefited if Pleasant Dam was breached. This may help explain why he requested the County Board of Supervisors' hearing. Cragin's accusations were also problematic because Cragin had previously been a strong proponent of multiple arch dams. In the early 1920s Cragin designed a multiple arch dam for the Salt River Project for the Pine Creek dam site on the Salt River. Cragin had also been involved in supporting the multiple arch design for Cave Creek Dam. Beyond his general objections to Pleasant Dam, it is particularly difficult to imagine how he could insist that Pleasant Dam would fail if overtopped. Cragin knew that two of Eastwood's multiple arch dams, Big Bear Valley Dam and Los Verjels Dam, survived overtopping because George Davenport had pointed this out to Cragin while Eastwood was trying to win Cragin's support for the Cave Creek design. Both Cragin and Reid also exaggerated the damage flooding would do to the Water Users' lands. As Lippincott had testified and shown in an inundation drawing presented as an exhibit at the special session hearing, the Agua Fria flood plain lay southwest or away from the Water Users' lands.[138]

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[138]Frank Reid and Cecil B. DeMille, the Hollywood
(Footnote Continued)

The most visible action taken by the Water Users' showing their objection to the Agua Fria project was an article printed in The Arizona Producer in April 1929. Although the article was unsigned, it was clearly the Water Users' work. The periodical was established, in part, by the Water Users', its office was located in the Water Users' building, and its issues were sent to all the Association's shareholders free of charge. The publication was generally viewed by the community as the Association's house organ. Titled the "Unpleasant Truth About Pleasant Dam," the piece used highly inflammatory language. It stated that Pleasant Dam was in danger of giving way and "snuffing out thousands of lives." The article accused Beardsley's organization of doing "nothing although innocent people living below [the dam] were in blissful ignorance of the terrible threat hanging over them." The article further charged that the District leaders were irresponsible and hence, "no tar [was] too black for them, no language adequate to depict their depravity."[139]

(Footnote Continued)
producer, had jointly purchased 3,100 acres within the Roosevelt Irrigation District. J. H. McClintock Newspaper Clipping File, nd, Phoenix Public Library. Cragin designed a 150 foot high multiple arch dam for the Pine Creek site seven miles downstream from Roosevelt Dam. (The dam was never built.) See C. C. Cragin, "Report to the President and Board of Governors of the Salt River Valley Water Users' Association on Additional Hydro-Electric Power Development on the Salt River," February 1922, 24-27, 335, copy available at the Salt River Project Research Archives. During the Cave Creek controversy, Eastwood wrote Davenport telling him that his Big Bear and Los Verjels dams had survived being overtopped. Davenport repeated this information to Cragin and attached Eastwood's letter to him telling him this when Davenport wrote Cragin three days later. John S. Eastwood to William Davenport, October 15, 1921; William Davenport to C. C. Cragin, October 18, 1921, Construction of Dam File, Project Secretary Files, Box 201-83. Concerning the Agua Fria flood plain, see Lippincott's exhibit sixteen in "Report of Joint Committee."

[139]The timing of the article only reinforced the Water Users' opposition because it came two months after Trott's order to lower the spillway. In the subsequent edition of The Producer, the Water Users' maintained their opposition to Pleasant Dam stating at the bottom of the editorial page, "In certain quarters, mention of the Pleasant Dam brings forth and [sic] unpleasant damn." "Unpleasant Truth About Pleasant Dam, Why State is Spending Huge Sum to Remove Menace Hanging Over Thousands of Lives and Millions of
(Footnote Continued)

The appearance of the buttress cracks in Pleasant Dam became more than a limited construction problem because the engineering community did not satisfy the demand to determine unequivocally what the cracks meant. Calculating the precise stability of Pleasant Dam was, however, not realistic. Assuming that engineers could, only complicated the problem. As Noetzli admitted, "the exact determination of principal stresses in the buttresses of multiple-arch dams is extremely complicated" [emphasis added]. Eastwood may have explained the difficulty best when he wrote that all calculations were based on subjective assumptions that "may be true or in error depending on the range of departure from the conditions for which they were assumed." Eastwood saw mathematical formulas therefore only as a guide after underlying assumptions were carefully made.[140]

But by not reaching a consensus on what the cracks meant and failing to explain the limitations of the design's technological application, the engineering profession failed to provide confidence in the structure. Many gravity designed dams had cracks, as Thomas Maddock clearly pointed out. Their safety, however, was not questioned. It was not that the cracks in gravity structures had been ignored, but that they had been countenanced over time. Rightly or not, there was confidence in Roosevelt Dam. Its design had been consciously affirmed. This was not the case for Pleasant. Despite the numerous technological advantages, the multiple arch held over gravity plans, and the previous successful use of the multiple arch design in the state, Pleasant Dam was not accepted for these reasons. Additionally, the extreme modifications made to the buttresses may have substantially aggravated circumstances and may have heightened the dam's questionable status. Hence, the dam

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Dollars Worth of Property," The Arizona Producer (April 1, 1929): 3, 7; The Arizona Producer (April 15, 1929): 6. Robert Beardsley stated in an undated memo that the editor of the Producer recalled four thousand copies of the issue and directed that they be shredded. Beardsley stated, "these things were done." Memo, Robert Beardsley, nd, MWD, 1920s Construction File. William Code's statements also posed a conflict of interest. As consulting engineer for Southwest Cotton, it was in his client's interests that he review Pleasant Dam unfavorably.

[140] Wegmann, The Design and Construction of Dams, 460. For a complete discussion of Eastwood's attitude towards design theory, see Jackson, "A History of Water in the American West," 486-524. Jackson stated that the analysis of multiple arch stresses "can become extremely complicated and esoteric."

became an easy target for debate for the state and for those organizations opposing the Agua Fria project.[141]

When the spillway modification was completed late that spring, Trott declared that the dam no longer posed a menace to the public. The dam was considered safe not because the cracks had been corrected, but because it was felt the reservoir's reduced water load supposedly would not challenge whatever effect the cracks had on the dam's integrity. Although Pleasant Dam could not store water above 130 feet, Beardsley and the District had one significant consolation. The dam had not been condemned, breached or altered. The Agua Fria project remained intact. The issue of the significance of the buttress cracks remained, but the District could decide independently how they would address them. Having withstood this engineering challenge, the District still faced another substantive battle. Southwest Cotton had filed suit against the District when Pleasant initiated construction, the cotton grower contended that the Agua Fria project would usurp their underground water right claims to the Agua Fria River. Beyond correcting the condition of Pleasant Dam, the

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[141]It is certainly ironic that multiple arch dams were not perceived as safe as gravity dams particularly since no multiple arch dams had failed. Besides St. Francis other gravity dams had recently failed: Austin Dam in Pennsylvania in 1911 and the Lower Otay Dam in San Diego 1916. In Arizona, the Walnut Grove Dam, a gravity masonry dam on the Hassayampa River, failed in the late nineteenth century killing an estimated fifty people. The Italian Gleno Dam, a multiple arch structure with a masonry base failed in 1923 but its demise was not structural but attributable to a very poor foundation. Concerning the Gleno Dam failure, see "Official Report on Collapse of Gleno Dam, Investigators Declare Design of Base Inadequate and Whole Structure Defective - Failure of Base Responsible," Engineering News-Record 93 (August 7, 1924): 213-215; Noetzli's comments in Wegmann, The Design and Construction of Dams, 513-516. For a discussion on the use or non-use of the multiple arch design beyond the 1920s, see Jackson, "A History of Water in the American West," 747-769. The engineering communities failure to explain the limitations of the design's technological application was the result of their strict adherence to mathematical analysis which caused them, as Edwin Layton wrote, to "give lip servcie to the idea of social responsibility." Edwin Layton, "Mirror-Image Twins: The Communities of Science and Technology in 19th-Century America," Technology and Culture 12 (1971): 562-580.

District now had to battle Southwest before its project could become operational.

Chapter VI, Southwest Cotton Litigation and Completing the Agua Fria Project

The cracks in Pleasant Dam's buttresses were not the only impediments Beardsley, Pleasant and the District faced in completing the Agua Fria project. The Southwest Cotton Company, located downstream from the project, opposed the Agua Fria development for reasons other than the perceived instability of the project's storage dam. As workers began to build the dam in 1926, Southwest Cotton, a subsidiary of the Akron, Ohio-based Goodyear Tire and Rubber Company, and the Valley Ranch Company, another downstream agricultural enterprise, sued to prevent the Maricopa Water District, the Beardsley Land and Investment Company, and Carl Pleasant from impounding the Agua Fria River behind Pleasant Dam. Southwest and Valley Ranch filed for an injunction against the District because the companies argued that storing the Agua Fria would dry up the groundwater wells which they were operating downstream. Like the controversy surrounding the safety of Pleasant Dam, the litigation brought by the cotton growers threatened the future existence of the Agua Fria project.[142]

When Goodyear Tire and Rubber determined that Southwest should file suit against the District in March 1926, it came as no surprise to Beardsley and the District, nor did it cause them immediate concern. After William Beardsley's sale of six thousand acres of the Agua Fria project service area to Southwest in 1916, the District and Southwest remained in frequent contact. Until 1925, Beardsley and representatives from Southwest and Goodyear discussed a variety of issues, including adding the cotton growers' Litchfield and Marinette ranches to the Agua Fria development, joining together in forming a state irrigation district, and purchasing stored water from the construction of the project's reservoir. Yet after Southwest congratulated Robert Beardsley on securing financing to construct the project in 1925, the company threatened litigation. When construction of Pleasant Dam began the following spring, the cotton grower dropped friendly relations and filed suit.[143]

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[142]Southwest Cotton and Valley Ranch filed their complaint against the Maricopa County Municipal Water Conservation District Number One, the Beardsley Land and Investment Company, and Carl Pleasant in the Maricopa County Superior Court on March 22, 1926.

[143]History, Goodyear Negotiations, nd. MWD, Southwest Cotton File. From the correspondence it appears that

(Footnote Continued)

Southwest's litigation challenging the project's development did not disturb Beardsley's lawyer, P. H. Hayes. In the fall of 1925, with the threat of litigation pending, Hayes wrote to Carl Pleasant concerning the matter while Pleasant was in New York City negotiating the sale of construction bonds to Brandon, Gordon and Waddell. Southwest's threat, Hayes wrote, would "appear to any one upon a moment's reflection as a childish utterance." Hayes thought that the worst possible result of the litigation would be for the courts to rule that the District would have to deliver to Southwest the equivalent of any flood water the cotton grower would have diverted if the dam was not in place. Hayes further disavowed Southwest's claim by informing Pleasant that the District's water rights were valid and uncontestable because the State Certification Committee reviewed its water rights prior to approving the project's construction. As Hayes stated, "it is the business of the State to know what it is doing."[144]

Carl Pleasant, certain of the soundness of the District's legal position, began construction of the project in the spring of 1926. Pleasant's Tulsa attorney, R. C. Allen, however, seemed more concerned about the litigation than Hayes. Allen recommended to Pleasant, one week after Southwest filed suit, that he should "quit work until the court acts," because if Southwest was awarded relief, "it would result in [the] entire loss of all sums expended." About one week after Allen wrote Pleasant, on April 9, 1926, he told the attorneys of Brandon, Gordon and Waddell that there was "absolutely no merit in the contentions of the plaintiffs." Evidently, while Allen thought it appropriate for Waddell's organization to risk its investment, he did not think that his client should take the same risk.[145]

When the case was heard by Judge Joseph S. Jenckes in Maricopa County Superior Court in 1927, Southwest Cotton and Valley Ranch asserted their water claims based on the doctrine of prior appropriation. Under this legal principle the first user of a stream or river has the first claim to

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litigation was not instigated by the local office of Southwest Cotton, but by the parent company, Goodyear Tire and Rubber. Litchfield Ranch was previously owned by Goodyear.

[144]P. H. Hayes to Carl Pleasant, October 29, 1925, MWD, Southwest Cotton File.

[145]R. C. Allen to Carl Pleasant, April 1, 1926, MWD, Southwest Cotton File; R. C. Allen to Messrs. Thomson, Wood and Hoffman, April 9, 1926, MWD, Southwest Cotton File.

the stream's water. Southwest reasoned that the water it pumped was from an underground stream which was fed by the surface flow of the Agua Fria River. If the District prevented the Agua Fria from flowing in its natural water course, Southwest argued, its wells would dry up. Since water from underground streams was considered to be public water, subject to the prior appropriation rule, and since Southwest had been using water from this underground source prior to the District's use, the cotton growers argued that the District should be enjoined from damming the river.[146]

The Maricopa Water District admitted that the downstream users were tapping water from an underground stream. This fact was meaningless, the District argued, because its own appropriative rights predated those of the cotton growers by twenty-seven years. Southwest had no valid appropriative right since the District's water rights dated from the Agua Fria Water and Land Company's work which began in 1888. The District's rights therefore preceded the 1909 and 1916 cotton growers' appropriations. Even if the date of the District's appropriation was not compelling evidence to drop the suit, the District argued that impounding the waters of the Agua Fria River would, in fact, actually benefit Southwest and not harm its agricultural enterprise. Soon after water was applied to the Agua Fria project lands, the District reasoned, the water table beneath the plaintiffs' acreage would actually rise. Irrigation water would percolate naturally from the District lands into the underground water table and replenish and increase the cotton growers' groundwater supply, not diminish it.[147]

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[146]The facts of the case have been somewhat simplified. In the state of Arizona, the courts had decreed that underground streams were subject to prior appropriation rights. Underground streams were defined much like surface streams, that is, they have a bed, bank and current. Judge Jenckes repeatedly referred to an underground stream in his findings of fact, conclusions of law, and decree as the "known, definite, dependent underground channels." See Howard v. Perrin, 8 Ariz. 347, 76 P. 460 (1904), and Proctor v. Pima Farms, 300 Ariz. 96, 245 P. 369 (1926) concerning state law regarding water appropriation rights. Percolating water, however, was the property of the landowner and not subject to appropriation. Representing the cotton growers was the Phoenix law firm of Armstrong, Lewis and Kramer.

[147]Land comprising the Marinette Ranch was previously owned by R. P. Davie who incorporated the Marinette Canal and Land Company on October 30, 1909. Marinette Canal and Land Company constructed a rock, earth and brush diversion dam and canal and began diverting water in 1911. Southwest

(Footnote Continued)

In September 1927, Judge Jenckes rendered his opinion in favor of Southwest and Valley Ranch. Jenckes agreed that the water pumped by Southwest was taken from an underground stream and was therefore subject to appropriation. Jenckes wrote, "there can be no other reasonable conclusion . . . that there exists the underground stream flow as contended for by the plaintiffs . . . ." The judge decided that the District's water right claim was invalid. The District did not make sufficient showing, Jenckes stated, to prove a "continuous and unbroken appropriation" since the 1890s. He wrote:

> While W. H. Beardsley who was the moving spirit of the enterprise from 1897 to the time of his death in 1925 devoted practically all of his time to its promotion, and too much cannot be said in praise of his untiring and unremitting efforts in its behalf, nevertheless the evidence does disclose that there were times during the long period of years when the strain upon his resources and upon his fidelity to the cause tempted him to treat it rather as a means of exploitation than as a project to be developed to a successful conclusion. And I do not say this in any spirit of criticism, for I do not think Mr. Beardsley can be censured if, when the terrific strain of carrying the burden of the enterprise through the years at times seemed to him to be more than he could bear, he contemplated, and in fact did attempt, the making of its disposal to others the means of acquiring a competence for himself in his old age and for his family when he might be taken from them; but the fact is nevertheless disclosed by the evidence that on several occasions his efforts were directed primarily, not to the development

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Cotton held approximately ninety percent of the shares issued by the Marinette Canal and Land Company. Valley Ranch's Litchfield Ranch was originally established by the Airline Water Company in December 1910. From 1910 through 1912, the company constructed the Airline Canal. In 1916 through 1917, Southwest acquired the Airline Water Company and repaired and enlarged the canal. Subsequent to Southwest's acquisition from Airline, Valley Ranch purchased lands from Southwest within the Litchfield Ranch. Surface water from the Agua Fria River and groundwater were conveyed through both canals to each ranch. Representing the District was the Phoenix law firm of Hayes, Stanford, Walton, Allee and Williams.

> of the project itself, but to the disposal of it for a consideration.[148]

Jenckes also dismissed the District's claim that stored water applied to its lands would eventually add to the water table used by the cotton growers. Jenckes stated that the percolating water produced by the District's activities "cannot in any manner affect plaintiffs' right to be afforded the relief to which they are entitled by reason of having made a valid appropriation of the underground waters of the Agua Fria River."[149]

If Jenckes' opinion did not devastate the District's irrigation plan, his legal decree, issued a year later in October 1928, did. The decree stated that Southwest Cotton held a valid appropriative right for 30,448 acre feet of water per year for 10,790 acres at the Marinette Ranch. Litchfield Ranch was credited with 38,770 acre feet of water annually for its 12,000 acres. Judge Jenckes refined his decision by specifically requiring that the District be prevented from storing water as follows:

> any and all of the surface discharges of said Agua Fria River and its tributaries not exceeding 1,000 cubic feet per second, and any part of so much of its surface discharges of more than 1,000 and up to and including 100,000 cubic feet per second as normally and in the course of nature would flow by Frog Tanks and Camp Dyer and sink into and be absorbed by the bed of said river . . . until there shall have been allowed to flow down said stream . . . 69,218 acre feet of water during each asuccessive period of twelve months . . . . "[150]

The Court's injunction reduced the District's storage rights to approximately half of the Agua Fria River's annual stream

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[148]Opinion, Southwest Cotton Company and Valley Ranch Company v. Maricopa County Municipal Water Conservation District Number One, Beardsley Land and Investment Company and Carl Pleasant, Maricopa County Superior Court, Case No. 23060-B, September 6, 1927, MWD, Southwest Cotton File.

[149]Ibid.

[150]Marinette Ranch was apportioned forty-one second feet of continuous flow. Litchfield Ranch was apportioned fifty three-second feet of continuous flow.

flow. Added to this problem was the beginning of a drought cycle. Only fifteen percent of the anticipated annual runoff flowed into the reservoir in 1928-1929. These events combined to make the future of the Agua Fria project appear more bleak than ever.[151]

Because of the severe financial strain caused by both concern over the dam's stability and the legal costs arising from Southwest's litigation, the District needed to issue another bond series for over one million dollars. Receiving permission to add to the District's existing $4.5 million indebtedness seemed impossible since the District could not show a sufficient water supply behind Pleasant Dam which would be necessary to convince the State Certification Committee of the project's economic soundness and so receive their approval to issue more bonds. The District was "stunned" as to how to obtain additional funds. The only "immediate hope," attorney Hayes thought,[152] would be to develop a hydropower generation plant.

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[151]The District was left with approximately forty-eight percent of the annual flow of the river. Jenckes' decision came three months after the District had notified the General Land Office that it had completed its entire storage and irrigation system. P. H. Hayes to William Spry, Commissioner, United States General Land Office, July 23, 1928, MWD, Southwest Cotton File. Inflow into Lake Pleasant in 1928-1929 was approximately 23,000 acre feet. Storage in the reservoir in 1928-1929 was 36,000 acre feet. Application of Maricopa County Municipal Water Conservation District Number One to Reconstruction Finance Corporation for Loan of $330,000.00, October 5, 1937, MWD, Finances File.

[152]The District was considering a bond issuance for $1.2 million. The Maricopa Water District initially issued $3.325 million in bonds for construction. In February 1927, it issued a second series for $1.175 million to cover changes in construction, the addition of more steel reinforcement and other modifications. This second series brought total indebtedness to $4.5 million. In a telegram to John Brandon, Waddell's partner, P. H. Hayes wrote, "Most serious immediate harm is we cannot now show sufficient water supply in support of proposed bond issue and certification board must pass upon water supply as condition of approving issuance of bonds stop doubt whether we could raise money for payment taxes under my plan in view of this decision stop sale of power seems only immediate hope left us." Beardsley and Waddell considered issuing 250,000 warrants against the construction account as a means of

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Developing hydropower generation had been seriously considered by the District in conjunction with Central Arizona Light and Power Company (CALAPCO) for several years. In 1927, CALAPCO hired Quinton, Code and Hill (the same consultants employed by Southwest Cotton) to determine the amount of hydropower generation the Agua Fria project could produce annually. Because there was a limited amount of long-term, accurate data concerning stream flow, and the cost to construct two hydroplants, estimated at $700,000, was beyond its ability to finance, the District did not pursue further the idea of a hydropower generation.[153]

It did not take Beardsley, Hayes, Waddell, Pleasant and the other District leaders long to determine that they could neither afford to improve the District's irrigation plan independently nor coexist along the Agua Fria with Southwest Cotton under the conditions mandated by Judge Jenckes. The District's only alternative was to appeal the Superior Court's decision to the State Supreme Court. It did so in December 1928. The District's appeal took on added importance immediately after it was filed. In the same month, Water Commissioner Trott issued his order restricting storage capacity at Pleasant Dam. Trott's ruling, which reduced storage behind Pleasant Dam to 73,000 acre feet of water, added to Jenckes' decision to let 69,000 acre feet flow past Pleasant Dam annually,[154] left the District with appreciably no water storage.

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refinancing but Hayes advised against this since he thought it might be fraudulent. P. H. Hayes to John R. Brandon, November 26, 1928 and November 30, 1928, MWD, Southwest Cotton File.

[153]CALAPCO has evolved into Arizona Public Service (APS). The plan for power generation was based upon a plant at Pleasant Dam, one at the river crossing flume and the possibility of two additional plants, one located upstream at another dam site, called Swenson, and one a few miles below the Swenson dam site. Quinton, Code and Hill estimated that for the years 1905 through 1922, fifty seven thousand kilowatt hours of hydropower could be generated per year. The consulting firm made no estimate of the economic feasibility of the hydropower option. Quinton, Code and Hill to Central Arizona Light and Power Company, December 7, 1927, MWD, Southwest Cotton File.

[154]Under the Superior Court's order, the District did not allow enough water to run down the river to the satisfaction of Southwest Cotton. In April, James Moore, attorney for Southwest, complained to the District's
(Footnote Continued)

Beginning in January 1929 and for two more years, the Arizona Supreme Court, the state's highest court, heard the District's appeal. The cotton growers again presented their argument that a reversal of the lower court's opinion would mean an abandonment of the prior appropriation principle. The District argued that affirmation of the lower court's ruling would make water storage subservient to groundwater pumping and inhibit the future development of surface water in the state. In October 1931, over five years after the cotton growers' filed for the injunction, the Supreme Court rendered its judgment. Judge Alfred C. Lockwood wrote the unanimous decision for the court.

In a lengthy and contorted opinion, the Supreme Court reversed the Superior Court's ruling. In his opinion, Lockwood first re-embraced the distinction between the two classes of underground water, namely percolating and subsurface stream. Whereas percolating groundwater was not subject to appropriation, being the property of the landholder, a subterranean stream was appropriable if it met specific criteria categorized as subsurface flow. Lockwood defined water from an underground stream as having the same characteristics as a surface stream: that is, a water course that has a well-defined bed, bank and current. Lockwood stated this explicitly, italicizing his statement that "There must be certainty of location as well as existence of the [underground] stream before it is subject to appropriation." For Southwest to have a valid appropriative claim, water drawn by the cotton growers' pumps had to meet this rule of law.[155]

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attorney Hayes stating, "It seems to us that if anybody is going to be short of water under this stipulation [court injunction] it should be the Beardsley project and not the Marinette Ranch. The way your clients are executing the stipulation makes it of practically no value to us . . . ." James R. Moore to Messrs. Hayes, Stanford, Laney and Allee, April 10, 1928, MWD, Southwest Cotton File.

[155] Maricopa County Municipal Water Conservation District Number One, Beardsley Land and Investment Company, and Carl Pleasant, v. Southwest Cotton Company, and Valley Ranch Company, 39 Ariz. 65, 4 P. 2d 369 (1931). Lockwood's fellow jurists concurring in the opinion were C. J. McAlister and J. Ross. The decision ran for thirty six pages. Lockwood believed that the Southwest case was "one of the most important which has ever come before this court . . . ," and one "which will in all probability determine and govern to a great extent the course of future agricultural development within the arid regions of Arizona."

Lockwood decided next what test ought to be applied to determine the existence of an underground stream. The best test, Lockwood reasoned, would be to determine if drafting of underground water would adversely affect surface flow. This is where the court's opinion became confusing. The question in the case was not whether pumping groundwater affected surface flow, but the reverse, whether impounding the river would adversely affect Southwest's pumping. Nevertheless, Lockwood seemed to say that that did not make any difference and ruled against the plaintiffs because the cotton growers, under this test, did not present the "slightest evidence" that their pumps affected surface flow. "We think," he wrote, "the body of water shown to exist beneath the lands of plaintiff [Southwest], and from which they draw by reason of their wells, . . . does not constitute the subflow of the Agua Fria River, for there is not the slightest evidence that their pumping diminishes directly or appreciably the surface flow . . . ." Lockwood completed this sentence with the phrase, "no matter how true may be the converse." This clause is particularly surprising since the converse of this statement, of course, represents the facts of the case. Lockwood concluded by stating that Southwest had "no rights of appropriation to the water pumped by them as a subflow of the Agua Fria River . . . ." [156]

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[156] In determining the existence of an underground stream, Lockwood wrote, "The best test which can be applied to determine whether underground waters are as a matter of fact and law part of the surface stream is that there cannot be any abstraction of the water of the underflow without abstracting a corresponding amount from the surface stream, for the reason that the water from the surface stream must necessarily fill the loose, porous material of its bed to the point of complete saturation before there can be any surface flow. Therefore the river bed must continue holding sufficient water to support the surface stream, as it were, for otherwise in drawing on the underground flow of the stream it will necessarily draw upon the waters flowing on the surface." Also, and again italicized for emphasis, Lockwood phrased the court's test by asking, "Does drawing off the subsurface water tend to diminish appreciably and directly the flow of the surface stream?" If Southwest could show that the water it was pumping was from an underground lake, the Court hinted their right to appropriation might be valid. Why the court regarded the relevancy of what effect pumping had on surface flow, but not the opposite, and what rights did a pumper of percolating groundwater have against a surface water

(Footnote Continued)

The Supreme Court's decision was a great victory for the District. However, it came at a considerable cost. The District lost several years in putting the project in operation because of the suit. The litigation also prevented the District from correcting the cracks in the dam's buttresses. If the District lost on appeal, there would have been little reason to renovate the dam. More importantly, Southwest's challenge seriously injured the District financially. Added to these problems was the death of Carl Pleasant in the spring of 1930.

Only forty-three years of age, Pleasant died of cerebral meningitis. His death, in one way, was as tragic as William Beardsley's. Although Pleasant completed the construction of the Agua Fria project, like Beardsley, he did not live to see the development succeed. Beyond the effect his death had on the District and his other business interests throughout the Southwest, which were reported to amount to several million dollars, his demise was most painfully felt by his family. Pleasant left behind his wife, Gertrude Copley Pleasant and five young daughters ranging in age from seven to sixteen.[157]

Financially, Southwest's litigation left the District in severe distress. When Lockwood's decision was rendered in the fall of 1931, the District already had been in default of its interest payments on its construction bonds for nearly two years. Combined with the drought that persisted through the early 1930s, the District needed funds to retire its $4.5 million in outstanding construction bonds and secure an alternative water supply. Ironically, the District needed to develop a groundwater program. The District also needed monies to repair Pleasant Dam and its

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diverter whose surface appropriation adversely affected the water level in the pumper's wells, are questions that are not answered by the opinion.

[157]Pleasant contracted an infection after undergoing a mastoid operation. Gertrude Pleasant survived her husband by many years. She married again, a Californian named Donald I. Cone, and lived the rest of her life on the coast. Pleasant's five daughters were: Nellie Catherine; Muriel; Elizabeth; Evelyn; and Marjorie. "Carl Pleasant: Builder of Dams and Empires," The Phoenix Gazette, March 29, 1980, MWD, Biography File. Other newspaper articles concerning Pleasant's death, not dated, are contained in the Biography File.

water distribution system.[158] All of this work was estimated to cost $1.35 million.

Under a complicated agreement reached in 1934, the District reorganized with federal assistance from the Reconstruction Finance Corporation (RFC). The RFC was created in 1932 under President Hoover as an economic recovery program to lend emergency financing to various business organizations, including farming associations. Under a bond purchase agreement with RFC, signed on February 1, 1934, the District created the Maricopa Power and Water Company. In return for fifteen thousand acres donated to the Company by the District, conveyance of the District's hydroelectric sites and rights, and for all revenues paid to the District beyond operating costs, the Maricopa Power and Water Company would operate and maintain the District, obtain an interest free loan of $1.35 million from the RFC needed to upgrade the District's system, establish a groundwater pumping program, and service the District's $4.5 million outstanding debt.[159]

The terms of the agreement stipulated that RFC would purchase $1.35 million of the District's outstanding construction bonds. The remainder of the bonds, worth $3.15 million, would be surrendered and cancelled. The $1.35 million obtained from RFC would be amortized over a period

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[158]The District defaulted on its interest payments to its first and second series bonds on January 1, 1930. Bondholders' Reorganization and Readjustment Agreement, July 18, 1934, MWD, Finances File; Application of Maricopa County Municipal Water Conservation District Number One to Reconstruction Finance Corporation for Loan of $330,000.00.

[159]The terms of the bond purchase agreement with RFC are very complicated, but the essential details are listed here. The agreement is sixty-seven pages long. Shareholders of the District's construction bonds approved the bond purchase agreement with the RFC under a separate agreement reached on July 18, 1934. This agreement was called the Bondholders' Reorganization and Readjustment Agreement. This document contains both the Bond Purchase Agreement with the RFC and the Bondholders' Reorganization and Readjustment Agreement. The Maricopa Power and Water Company no longer exists as a corporation. Ownership of the District's lands was held principally by the Beardsley Land and Investment Company and the Arizona Citrus Land Company; collectively, they held 34,000 acres. Upgrading the District's system consisted of strengthening the dam, restoring the spillway, replacing wooden structures, regrading and lining the canal, and rehabilitating laterals and sub-laterals.

of thirteen years. These monies would be used to make the improvements needed at Pleasant Dam and the District's canal system, and establish a groundwater pumping program. To repay the $4.5 million construction bonds, Maricopa Power and Water would issue debenture bonds for $1.125 million at three percent interest, one half the rate of the original construction bonds, and $3.375 million in income bonds at a variable interest rate. Amortization of these bonds was long term and dependent on the Company first repaying its RFC loan.[160]

Refinancing under the RFC permitted the District to make repairs to Pleasant Dam and upgrade its water delivery system which had fallen into a state of disrepair during the years of litigation. Even this work was not undertaken without another legal dispute. The State Attorney General, Arthur T. La Prade, refused to approve the District's federal loan because he believed the state's District Enabling Act of 1934, which permitted irrigation districts to borrow money from any federal agency for any district purpose, was unconstitutional. With no alternative, the District was forced to file suit against the Attorney General to get its bonds authorized. Again the case was taken to the state Supreme Court and ruled upon by Judge Alfred Lockwood. Lockwood refuted La Prade's lengthy complaint, held the act constitutional, and ordered La Prade to examine the bonds for certification. The bonding

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[160]Debenture and income bonds are typical instruments used in long-term debt financing. Income bonds typically arise from corporate reorganizations. These bonds are attractive because they pay interest only if income is actually earned by the company. The District obtained additional financing in the amount of $600,000 from RFC and the Federal Emergency Administration of Public Works in 1937. These loans were obtained at a four percent interest rate and amortized over a long term schedule. In 1944 the District again refinanced its debt. As of December 1985, the District had $669,000 in unmatured bonds. The District will retire this debt in 1992. Application of MWD to RFC for Loan of $330,000. See also, Maricopa County Municipal Water Conservation District Number One, Financial Statements and Other Financial Information, For the Six Months Ended December 31, 1985, April 11, 1985, Lucas and Mathews, Certified Public Accounts, Phoenix, Arizona, MWD, Finances File. Interview with John Lucas, Lucas and Mathews, Phoenix, Arizona, July 20, 1987.

agreement received approval after the litigation was settled.[161]

The La Prade litigation, however, did not delay rehabilitation work planned by the District. The District received authorization from the State Certification Committee to improve its storage dam and water system in the spring of 1934. Work began immediately. At Pleasant Dam, improvements were made to the buttresses, the dam's crest, and the spillway.

Rehabilitation of the buttresses generally consisted of three activities. First, a heavily reinforced addition to the water slab was added downstream and parallel to, but not integral with, the existing water slab. Second, five elevations of reinforced concrete floors extending from the new water slab through the length of the buttresses were added. This improvement was basically Noetzli's original recommendation. Mass concrete was poured at the base of each buttress for ten feet in elevation. Third, existing cracks were pressure grouted. Rehabilitation of the dam's crest consisted of replacing the narrow walkway at the top of the dam with a wider roadway. Improvements made to Pleasant Dam were engineered by the District, with the assistance of the consulting firm of Quinton, Code, Hill, Leeds and Barnard. The work was performed by Joe Pleasant, Carl Pleasant's brother.[162] (See photos AZ-11-44 through AZ-11-46.)

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[161] La Prade's complaint ran for, as Lockwood stated, "a mere trifle of some 350 pages . . . ." Lockwood found that the District's authorization to contract for federal loans was not an unconstitutional delegation of legislative powers, as La Prade argued, because the powers delegated to the irrigation districts under the legislation were limited to those necessary to carry out the purposes of the districts, even if they were not a political subdivision of the state. Irrigation districts would receive political subdivision status later. Lockwood ruled on several other legal points in this case. They are not discussed above. Maricopa County Municipal water Conservation District Number One v. La Prade, 40 P. 2d 94 (1935). The case was decided on January 17, 1935.

[162] W. W. Lane, "Dam Buttresses Strengthened," Engineering News-Record 116 (June 18, 1936): 867-870. "Application and Supporting Data, January 26, 1924, Waddell Dam," W. W. Lane to T. S. O'Connell, state engineer, January 26, 1934, MWD, Construction File; Specifications for the Construction and Reconstruction of the Irrigation Works of

(Footnote Continued)

Work at the spillway consisted of removing a twelve-foot high collapsible wooden weir that the District had constructed in the spillway cut in 1931. The weir had replaced a rock and earthen dike that the state had put in the spillway cut after it had completed its emergency work in 1929. The dike was added to mitigate the dramatic effect lowering the spillway had on the reservoir's storage capacity. It was hoped that the ten-foot earthen embankment would add nineteen thousand acre feet to the reservoir. Unfortunately, the dike did not work because it leaked excessively. The District first considered replacing the dike with a twelve-foot masonry spillway wall. However, Cragin and Southwest Cotton's consulting engineer, William Code, thought it would be unsafe to raise the spillway cut with a more permanent structure, even though the District planned to set explosives in the stone work to allow its removal in the event of a large flood. To appease their objection, the District constructed a wooden weir which Cragin suggested. Under the rehabilitation effort in 1935, the District replaced the weir with one sector gate and four Taintor gates.[163]

(Footnote Continued)
the District, December 1, 1934, MWD, Reports File. Improvements were made under nine categories. The specifications referred to Pleasant Dam as the Maricopa Dam. Weekly progress reports made by the state for the period April 1935 through February 1936 are in MWD, ADWR 1935 Inspection Reports File. The sector gate was a patented design and obtained from the Zurich, Switzerland firm Stauwerke. Quinton, Code, Hill, Leeds and Barnard were formerly Quinton, Code and Hill, the firm which was employed by Southwest Cotton. Quinton, Code and Hill also assisted the state in approving the construction design. W. W. Lane to T. S. O'Connell, state highway engineer, March 16, 1935, MWD, ADWR, Waddell Dam 1932-1952 File. Joe Pleasant operated the firm of Pleasant and Hasler Contracting Company.

[163]The dike could be added because the state determined that the dam could safely store water to 142 feet. The spillway cut was made to 130 feet. In the event of flood, the earthen embankment would be easily washed away by flood waters. Cragin did not believe that the method of removing the concrete dam with explosives would provide "sufficient safety" in the event of flood. He therefore recommended a collapsible weir. Cragin and Code's objections may be viewed as further evidence of their prejudice against the Agua Fria Project. See correspondence dated: April 29; May 11; June 11, 15-16, 19, 26; July 7, 9, 11, 28; August 1, 3, 17, 21; and December 1, 1931, MWD, ADWR, Waddell Dam 1931 File.

Improvements to the water distribution system under the refinancing agreement consisted generally of replacing features along the District's canal and laterals. Wooden weirs, flumes, overpasses, turnouts, culverts, drops, and other structures were replaced with similar structures using more permanent reinforced concrete. Lining sections of the canal was done by spraying gunite (a type of concrete) and by dumping silt and sawdust into the lower lake behind the diversion dam.[164]

RFC refinancing along with Public Works Administration funding also enabled the District to develop a $600,000 groundwater pumping program. Since the Agua Fria watershed had experienced a drought since 1927, the addition of groundwater was a desired contribution to the project's operation. Through federal financing, forty-seven groundwater pumps were constructed along the District's canal and lateral system. The addition of groundwater to the project's surface supply contributed approximately 250 second feet of water, or over fifty thousand acre feet annually, to the project's development. The groundwater pumping project also necessitated the construction of a central substation, twenty-six miles of power lines, forty-seven substations, one at each well, and an addition of eight miles of laterals for better distribution of pumped water.[165]

The success of the Agua Fria project was secured with the completion of the rehabilitation work to Pleasant Dam in 1935. Forty-seven years after the development was conceived by the Agua Fria Water and Land Company, the District delivered stored water, without protest, to lands within its service area. The rehabilitation work at Pleasant Dam resolved the controversy surrounding the dam's stability. The reversal of Southwest's injunction, a decision the cotton grower did not contest, returned to the District nearly all the water the Agua Fria project claimed prior to 1926. The refinancing agreement with RFC enabled the

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[164]Specifications for the Construction and Reconstruction of the Irrigation Works of the District.

[165]The groundwater pumping project was financed by the original loan made by RFC in 1934 and the subsequent funding the District received in 1937 from the RFC and the Federal Emergency Administration of Public Works. MWD to T. S. O'Connell, State Engineer, December 31, 1936, MWD, 1930s Construction File; "The Irrigation Water Supply of Maricopa County Municipal Water Conservation District Number One, Maricopa County, Arizona, December, 1941," MWD, Water Supply File.

District to restructure its debt, remedy its engineering problems, and develop a supplemental water supply. Added to these successes was the cessation of the drought. In the winter of 1936-1937, the District's reservoir received over 100,000 acre feet of water.[166]

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[166]Application of Maricopa County Municipal Water Conservation District Number One to Reconstruction Finance Corporation For Loan of $330,000. The reservoir was filled for the first time in 1940-1941.

Chapter VII, Conclusion

Throughout its development the Agua Fria project faced a seemingly endless succession of difficulties. Litigation, federal requirements, restrictions, and engineering problems all challenged the project. Beyond these complications, the project was delayed and hampered most by persistent financial problems. Through the long course of its evolution, the lack of investment always troubled the Agua Fria development.

After three years were taken to raise funds, the Agua Fria Construction Company began the project's diversion dam and canal in 1894. Even though construction began the operation was still tenuous at best. After only one year's progress the development could not overcome the small loss due to flood. Although the flood event contributed to the project's problems, the development closed because it simply ran out of money. The need for extensive excavation did make the construction more difficult than expected, but cheap labor offset the additional cost. If the need for the project's diversion dam was ill-considered and consequently a misuse of funds, as Davis suggested, Beardsley still may have never raised enough money to begin work at the storage dam site. If he did, he probably would have found his funds even more quickly spent with much less formidable progress made in the river bed.

In 1897 the Agua Fria project miraculously survived bankruptcy after its assets had been surrendered and auctioned. Nevertheless, the development lapsed for five years without financing until it was thwarted by national water storage efforts. If the project had showed more progress during this period, perhaps it may have been more successful in protesting Newell's callous attitude towards it.

The Santa Fe Railroad land exchange in 1914 and the Goodyear sale two years later greatly improved the project's finances and chances for completion. But at the time these gains were offset by the Maricopa Development Company's due diligence charges which began in 1909. The General Land Office eventually dismissed Maricopa's petitions on their own subsequent petition to show cause. Either challenge, however, would not have been brought if the project had money to perform any actual construction work over twenty years.[167]

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[167]Beardsley may not have successfully negotiated the land swap without the assistance of the Washington lawyers'
(Footnote Continued)

The project's poor financial situation was also a contributing factor leading to the controversy concerning Pleasant Dam's buttress cracks. When plans were drawn for the storage reservoir, Peckham and James selected the multiple arch design essentially because of the economic incentives the design offered. But the drive to reduce costs also caused the designers to modify the dam even further. The top of the structure was changed to cut the buttresses sixteen feet from normal height to save more money. When the temperature cracks appeared, the shortened buttresses only worsened and complicated the issue concerning the dam's stability.

Finally, after the District defeated Southwest Cotton's water right claim in 1931, its finances were completely spent. The District's victory over Southwest may have become meaningless had it not been for federal assistance from the Reconstruction Finance Corporation (RFC) in 1934. More important perhaps than the Santa Fe agreement and the Goodyear sale, refinancing from the RFC came at a critical time for the District. It had neither the funds to meet its $4.5 million construction debt nor was it able to upgrade Pleasant Dam or initiate a needed groundwater program. The RFC gave the District sound financial status when it had none. It enabled the District to put its project into operation.

After reviewing the project's financial history, one question appears obvious. Why was it so difficult for the project promoters to find investors? Why did it take nearly forty years to build the project with its completion coming only after it was revived by funding from the federal government? The Salt River Valley certainly had proven itself as a successful agrarian community, so much so that the federal government selected the Valley for one if its first reclamation projects. Eastern capital had invested in

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(Footnote Continued)
Britton and Grey. Beardsley employed these men, as did many others, to win Land Office approval. Britton and Grey could influence the Land Office's decisions because they were formerly employees of the department and had relatives still working in the office. For a good discussion on how the General Land Office was influenced by parochial interests, see Harold H. Dunham, "Some Crucial Years of the General Land Office, 1875-1890." Agricultural History 11 (1937): 117-141. Dunham's essay also appears in Vernon Carstensen, ed., The Public Lands, Studies in the History of the Public Domain (Madison: The University of Wisconsin Press, 1963), 181-201. See also James Garfield to Britton and Grey, February 24, 1909, MWD, Land Restoration File.

the many resource development projects in Arizona, why not the Agua Fria project?

At first glance, the answer may be the unusual misfortune or bad luck that impeded the Agua Fria project's chances. From the General Land Office's refusal to approve the project's maps in the 1890s to the La Prade case in 1934, the development was always buried in setbacks and delays. The more legitimate answer may be that, comparatively, it was no more difficult for the Agua Fria project to acquire financing than other private water storage developments. Many private water storage projects were planned in central Arizona on the Salt, Verde, New, and Gila rivers, many using eastern money. All failed because the capital requirements for the projects beyond the planning stage could not be met. While an extensive water transmission system was constructed in the Salt River Valley by private efforts, water storage projects were not. They proved too expensive. When the Valley's first storage dam, the federally sponsored Roosevelt Dam, was constructed, the high price of the work became quickly apparent. Although the federal government may not have been as motivated as private enterprise to be cost efficient, the Salt River Project ran more than three times its original estimate. In fact, the Service's first twenty-four projects averaged 175 percent over initial estimates.[168]

If water storage projects were too expensive for private development, how did the Agua Fria project succeed at all? It had help. Critical to the development's success was the 1904 federal Indian Appropriation Act. The act enabled the Santa Fe Railroad to acquire the project's service area lands which it could then sell to Beardsley to be used for the project's collateral. The state's creation of irrigation districts in 1921 also enabled the project to convert from a strictly private entity to a more public one with financing and regulatory advantages. Refinancing from

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[168] See footnote four concerning other private efforts to develop water storage projects in central Arizona. The 175 percent is the increase in per acre cost. The Reclamation Service projects' cost increases varied from thirty percent to over 500 percent. Arizona's only other Reclamation Service project, the Yuma Project, ran over 300 percent of its original per acre cost estimate. See Dorothy Lampen, Economic and Social Aspects of Federal Reclamation (reprint ed., New York: Arno Press, 1979), 49-75.

the federal RFC also gave the project[169] assistance at a crucial time in its development.

Since the Agua Fria project had a long, troublesome history, the development's ultimate success is attributable to several individuals. It is easy to celebrate Pleasant and Waddell's accomplishments. These men figured prominently in the completion of the project. The name of the reservoir and dam duly commemorate their effort. But the project's success really lies with William Beardsley. This can be said despite many reservations. Beardsley did not help organize the Agua Fria Water and Land Company. He did not map any of the project's features. He never completed the project's diversion dam and when he died in 1925, he left the development no more physically improved than it was thirty years earlier. He can even be criticized for "using" the project at one time, as Judge Jenckes accurately concluded, "as a means of exploitation." Nevertheless, Beardsley did do two things that should not be overlooked or underestimated. He acquired the project's service area lands which gave the District the collateral which it would use ultimately to finance the project. More importantly perhaps, Beardsley sustained the project. He recovered the project after bankruptcy, fought for the restoration of its service area, defended against several due diligence challenges, and hired Pleasant to plan the project's storage dam. Beardsley's efforts might also be admired because he was committed to developing the project for reasons other than personal profit. Beardsley was independently wealthy. In 1911 Land Office agent Hayworth estimated his worth at $200,000. Beardsley did not have any other business interests nor did he need employment. For most of the thirty-three years that he was involved, Beardsley was the project. He carried it alone. One has to look with wonderment and admiration at his obsessive, obdurate persistence in developing the project. As his son Robert testified in the Southwest Cotton case, the Agua Fria project was his father's life.

The most complex problem the Agua Fria project faced was the debate following Pleasant Dam's construction. What effect did the vertical cracks in the dam's buttresses have on the

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[169]For a good discussion on irrigation districts, see John D. Leshy, "Irrigation Districts in a Changing West -- An Overview," Arizona State Law Journal 1982 (1982): 345-376. Today the Maricopa Water District's status lies somewhere between a private organization and a public municipal corporation with state political subdivision powers. Concerning irrigation district's organizational status, see Leshy's comments at pages 349 through 353.

dam's stability or safety? Donald C. Jackson, in his dissertation on John Eastwood's multiple arch dams, suggested that the controversy stemmed not from the design itself but from the personalities that controlled it. This conclusion may be applicable here. Jackson wrote that, "so-called `technical' arguments formed the basis for whether or not engineers accepted or rejected the desirability of multiple arch dam construction." "However," Jackson followed, "to assume that reasoned analysis strictly determined the technology's ultimate fate is naive."[170]

In the case of Pleasant Dam, Davenport, Noetzli, Jakobsen, Lippincott and others all struggled with formulae in determining the stability of Pleasant Dam. But since their "technical" analysis could produce neither definitive answers nor even a consensus among themselves, Pleasant Dam naturally became open to wide evaluation based more on individual judgment. It was here that the debate became controversial. Just as the temperature cracks plagued Eastwood's Lake Hodges Dam causing, as Jackson stated, "a major attack on the dam's stability," so, too, did the buttress cracks at Pleasant Dam cause severe criticism by opponents of the project resulting in forcing the eventual rehabilitation of the storage work.[171]

The Pleasant Dam controversy may not have erupted, or not to the extent it did, if the state of Arizona had provided better leadership. Having not previously addressed the issue of dam safety and uncertain of its own authority, the state responded almost reluctantly. The State Certification Board was authorized to review and evaluate irrigation projects but after plans were approved, there was no clear understanding what subsequent action the state could take. Although State Engineer Lefebvre assigned Fraps to make an investigation concerning the condition of Pleasant Dam, all he could do was urge Beardsley to adopt Fraps' conclusions. He had uncertain authority. Whatever power the state had resided with the Water Commissioner. Commissioner Trott, however, apparently remained unaware of the situation for almost two years. At the special session hearing, Trott stated that he had no knowledge of any reports other than the Lippincott, Henny and Ransome study. He said his office received a copy of their report but he did not indicate that he had read it. Trott stated that he only learned of the situation on December 28, 1928, three days before he issued

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[170]Jackson, "A History of Water in the American West," 774.

[171]Jackson, "A History of Water in the American West," 754.

his storage restriction order. The legislative special session hearing formally brought the Pleasant Dam dispute to the state's attention in January 1929, a full two years after the cracks were identified. Legislative measures giving the state regulatory control over dam safety immediately followed the hearing but by the time the state established these measures,[172] opinion had already formed against Pleasant Dam.

The fate of multiple arch technology after the Pleasant Dam controversy has been adequately discussed by Jackson. Critics of the Agua Fria project and Eastwood's multiple arch designs soon won out after Pleasant Dam was completed. After 1930 the use of the multiple arch design essentially ended. Jackson wrote the design's epitaph stating,

> forget their exemplary safety record;
> forget that some were actually built
> with artificial expansion joints to take
> the place of natural hairlines [sic] cracks;
> forget their ability to conserve material
> and eliminate the hazards of hydrostatic
> uplift. Despite their economic attractiveness,
> multiple arch dams were relegated to the
> scrapheap of obsolete technologies that could
> no longer contribute to society's growth.[173]

It is interesting to note that the multiple arch would appear again in the Salt River Valley. Ironically, the Salt River Valley Water Users', strong opponents of the Agua Fria project, in conjunction with the Bureau of Reclamation, would again take advantage of the economic attractiveness of the design and build Bartlett Dam on the Verde River in the later 1930s using a multiple arch design.

Today, the Maricopa County Municipal Water Conservation District operates its irrigation project with great success. Pleasant Dam, renamed Waddell Dam in the early 1960s, has performed without incident and no deleterious affects related to the buttress cracks have ever been reported. The diversion dam and canal have also operated satisfactorily. The District has not added any hydropower generation facilities to its operation nor has it built any other storage dams on the Agua Fria River, though both additions

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[172] It should be remembered that Trott was not a member of the State Certification Committee. "Report of the Joint Committee," 67-69.

[173] Jackson, "A History of Water in the American West," 747-769.

have been frequently studied. Essentially, except for maintenance improvements, the project operates the same as it has for the past fifty years. Recently, the District has contracted for a Central Arizona Project water allowance and is now supplementing its water supply with Colorado River water. Financially, the District has reversed the Agua Fria project's early history of financial problems to become very successful.[174]

The District's service area lands have been very productive over the past fifty years producing a variety of farm goods including cattle, cotton and citrus. Perhaps the most successful operation in the District was run by Donald Waddell. (See photo AZ-11-48.) Sometime before 1931, Waddell disassociated himself from his New York associates and along with other business partners acquired well over thirty thousand acres within the service area under the name of the Arizona Citrus Land Company. Waddell eventually sold all his holdings in the District, but not before his lands provided him with a good livelihood and handsome profit for his family.[175]

The Agua Fria project, now almost one hundred years old, will soon be drastically changed. The Bureau of Reclamation is presently constructing a larger storage dam, an earthen type structure, called New Waddell Dam, slightly downstream from the present dam. The Bureau will also construct a new diversion dam as well to serve the Maricopa Water District. Waddell Dam will remain; however, it will be submerged under the new lake and act as a silt trap. The Maricopa Water District will survive but it will not own or operate New Waddell Dam. It will appropriate water from the new reservoir for its service area and convey it as it has traditionally through its canal and lateral system.

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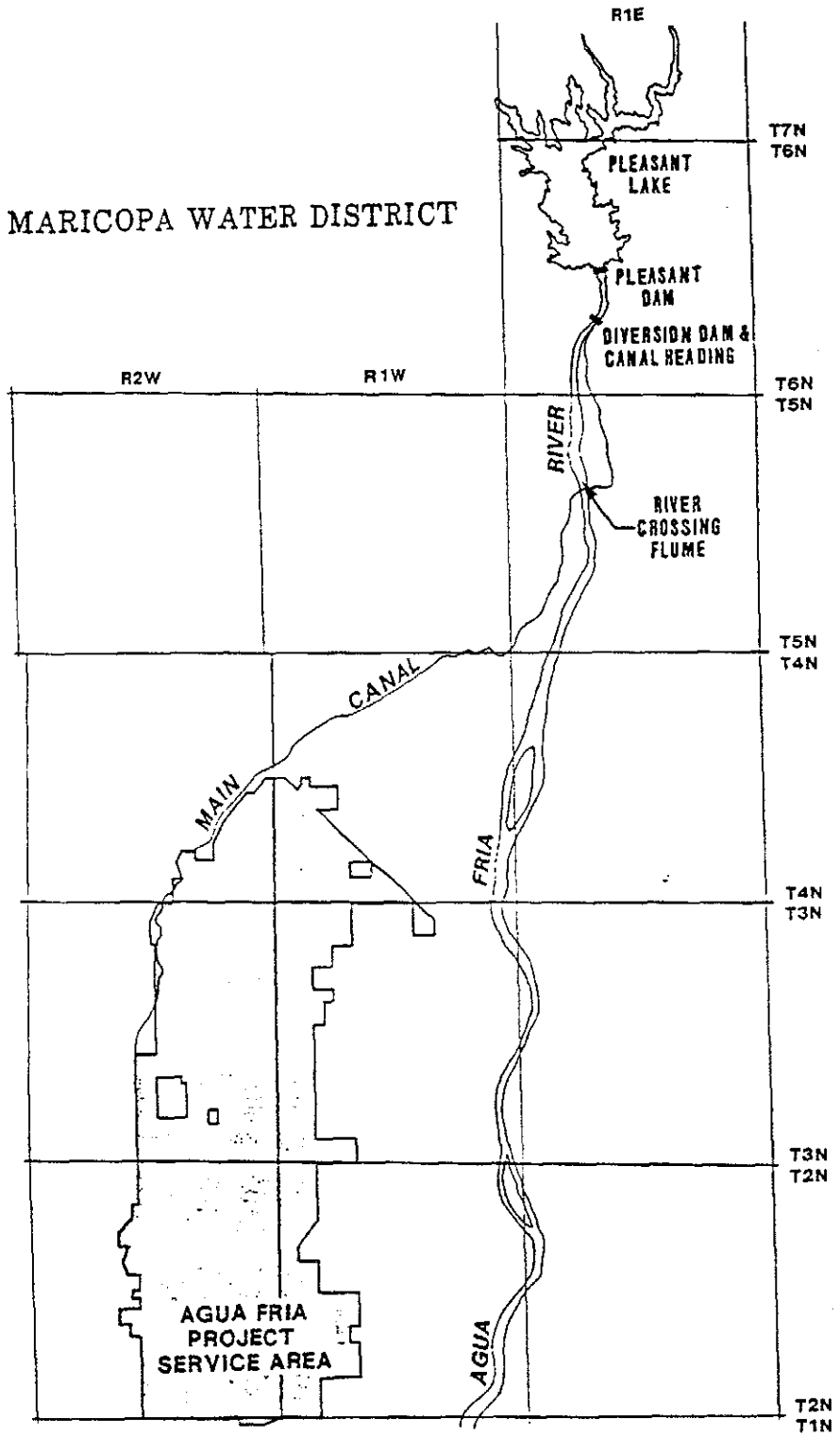
[174]As of 1985, the District has invested over $4 million dollars in certificates of deposit.

[175]Interview with Mrs. Eleanor Libbey, 25 November 1986. The history of the project's service area is not without its own controversy or scandal. In the late 1920s Romola Farms Incorporated, a California corporation, purchased a large tract of land within the Maricopa Water District. Romola advertised nationally for investors to fund a large grapefruit development it planned for its lands. In 1931 several of Romola's officers, including its president, Alexander Hursh, were convicted of mail fraud in marketing the project. Carl Pleasant was briefly involved with Romola before his death in 1930.

APPENDIX 1

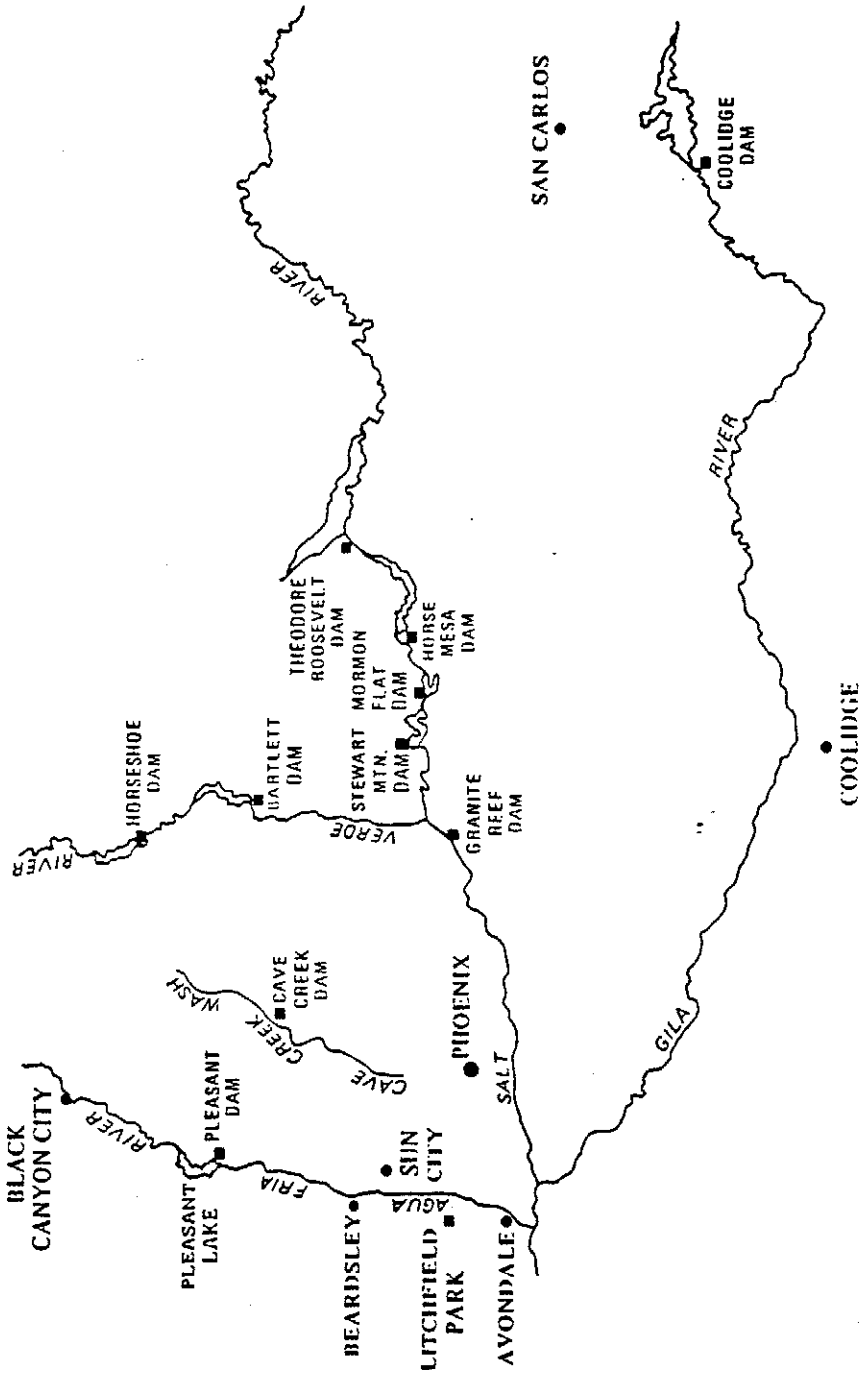
Agua Fria Project Service Area Lands Presently Served By The Maricopa Water District


MARICOPA WATER DISTRICT
R1E
T7N
T6N
PLEASANT LAKE
PLEASANT DAM
DIVERSION DAM & CANAL HEADING
R2W
R1W
T6N
T5N
RIVER
RIVER CROSSING FLUME
T5N
T4N
CANAL
MAIN
FRIA
T4N
T3N
T3N
T2N
AGUA FRIA PROJECT SERVICE AREA
AGUA
T2N
T1N

APPENDIX 2

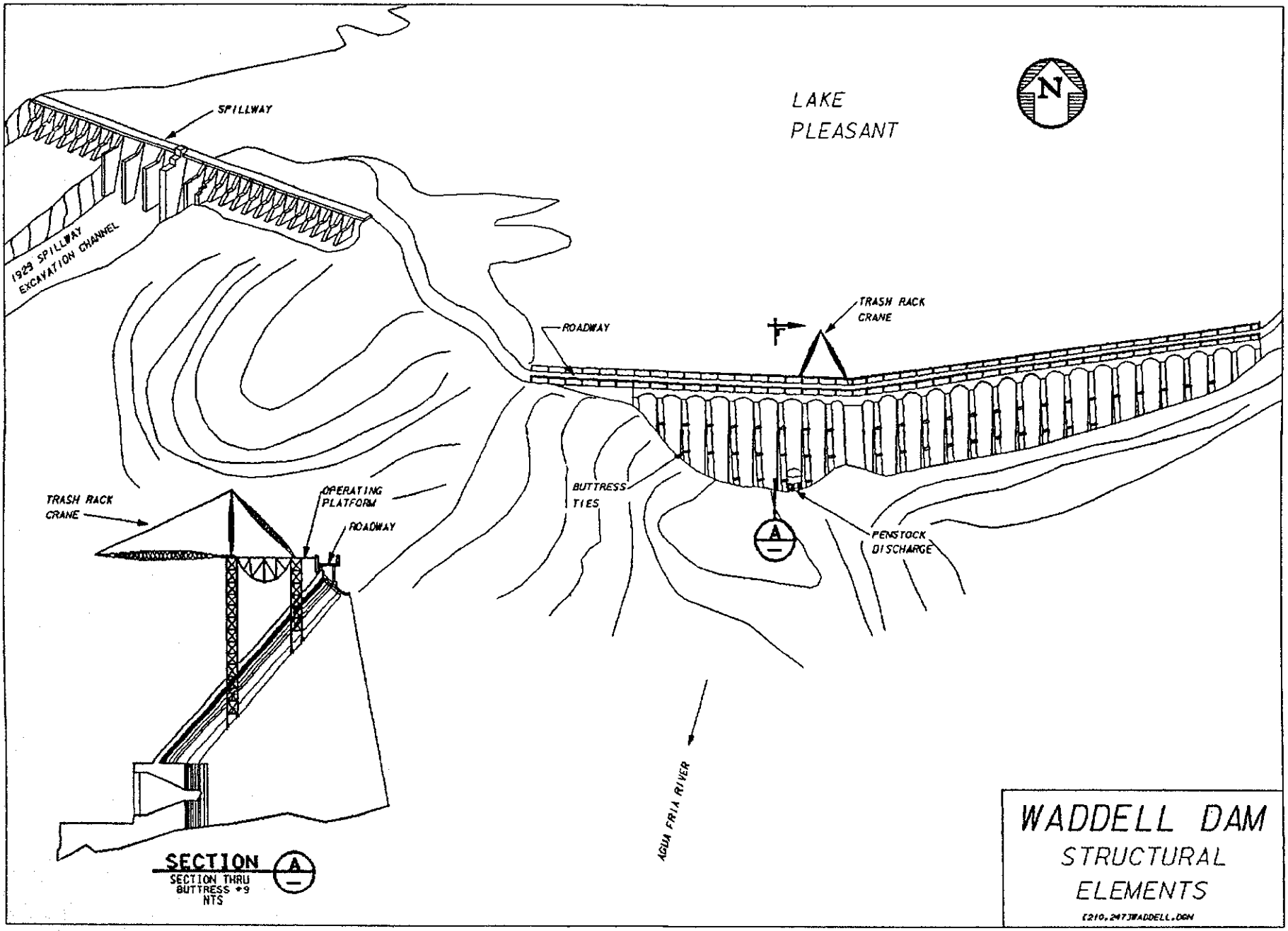
Principal Dams In Central Arizona

Waddell Dam
HAER No. AZ-11
122



APPENDIX 3

Waddell Dam
Structural Elements


LAKE
PLEASANT
N
SPILLWAY
1929 SPILLWAY
EXCAVATION CHANNEL
ROADWAY
TRASH RACK
CRANE
BUTTRESS
TIES
PENSTOCK
DISCHARGE
A
TRASH RACK
CRANE
OPERATING
PLATFORM
ROADWAY
SECTION A
SECTION THRU
BUTTRESS #9
NTS
AGUA FRIA RIVER
WADDELL DAM
STRUCTURAL
ELEMENTS
[210,247]WADDELL.DGN

Bibliography

I. Manuscript and Archival Collections

Arizona, Tempe. Arizona Historical Collection, Arizona State University.

_____. Arizona Historical Foundation, Arizona State University.

_____. Arizona Historical Collection, Arizona State University.

_____. Research Archives, Salt River Project.

Arizona, Phoenix. Arizona Department of Water Resources (ADWR).

_____. Arizona State Library and Archives.

_____. Maricopa County Recorder's Office.

_____. Maricopa County Superior Court.

_____. Phoenix Public Library, James H. McClintock Newspaper Clippings File.

_____. State Supreme Court.

Arizona, Waddell. Maricopa County Municipal Water Conservation District Number One.

California, Berkeley. Water Resources Library, University of California at Berkeley.

California, San Francisco. Leedshill Herkenhoff Engineering Firm.

Kansas, Topeka. Records of the Santa Fe Railroad, Kansas State Historical Society.

Ohio, Hamilton, Butler County Historical Society and Museum.

Washington, D.C. National Archives and Records Administration, Record Group 49, Records of the General Land Office.

II. United States Government Documents

United States Department of Interior. Geological Survey. Irrigation Near Phoenix, Arizona, by Arthur P. Davis. Water

Supply and Irrigation Paper No. 2. Washington, D.C.: Government Printing Office, 1897.

_____. Reclamation Service. Annual Reports of the U.S. Reclamation Service, 1902-1904.

III. Newspapers

Arizona. Globe, Arizona Weekly Journal Miner.

Arizona. Phoenix, The Arizona Democrat.

_____. The Arizona Gazette.

_____. The Arizona Republican.

IV. Theses and Dissertations

Davison, Stanley Roland. "The Leadership of the Reclamation Movement, 1875-1902." Ph.D. dissertation, University of California, 1952.

Henderson, Patrick, "The Public Domain in Arizona: 1863-1891." Ph.D. dissertation, University of New Mexico, 1965.

Hornig, Edgar Albert. "Reclamation of Arizona's Arid Lands." M.A. Thesis, University of Oklahoma, 1942.

Jackson, Donald C. "A History of Water in the American West: John S. Eastwood and `The Ultimate Dam' (1908-1924)." Ph.D. dissertation, University of Pennsylvania, 1986.

Mawn, Geoffrey P. "Phoenix, Arizona: Central City of the Southwest, 1870-1920." Ph.D. dissertation, Arizona State University, 1979.

V. Articles and Other Papers

"Apaches and the Magic Water, Historical Sketch of the Discovery of Castle Hot Springs, Reminiscences of a Pioneer," Arizona Magazine (March 1914): 6, 11.

Dunham, Harold H. "Some Crucial Years of the General Land Office, 1875-1890," Agricultural History 11 (1937): 117-141.

"How Should We Figure Foundation Pressures in a Multiple Arch Dam?" Engineering News-Record 88 (April 13, 1922): 623-624.

Ganoe, John T. "The Beginnings of Irrigation in the United States," Mississippi Valley Historical Review 25 (June 1938): 59-78.

Griggs, C. E. "Highest Multiple Arch Dam in United States," Western Construction News 1 (March 25, 1926): 23-27.

Introcaso, David M. "The Roosevelt Power Canal and Diversion Dam," National Park Service, Historic American Engineering Record Report, AZ-4, 1984.

_____. "Water Development on the Gila River: The Construction of Coolidge Dam." National Park Service, Historic American Engineering Record Report, AZ-7, 1986.

"Irrigation In Arizona," The Irrigation Age 5 (July 1893): 55.

"Jakobsen, Bernard Faaborg," in Who's Who in Engineering edited by John William Leonard, p. 1076. New York: Who's Who Publications Inc., 1925.

_____. "Stresses in Multiple Arch Dams," Proceedings of the American Society of Civil Engineers 49 (August, 1923): 1093-1131.

_____. "Stresses in Multiple-Arch Dams," Transactions, American Society of Civil Engineers 87 (1924): 276-341.

Jorgensen, Lars. "Safety Factors in Multiple Arch Dams," Journal of Electricity 42 (April 1, 1919): 327-328.

"Lake Pleasant Dam," Engineering News-Record (February 14, 1929): 275.

"Lake Pleasant Dam, Near Phoenix, Will Be the Highest Multiple Arch Dam in the World," Modern Irrigation 3 (June 1927): 30-31, 60.

Lane, W. W. "Dam Buttresses Strengthened," Engineering News-Record 116 (June 18, 1936): 867-870.

Leshy, John D. "Irrigation Districts in a Changing West - An Overview," Arizona State Law Journal (1982): 345-376.

Layton, Edwin, "Mirror-Image Twins: The Communities of Science and Technology in 19th-Century America," Technology and Culture 12 (1971): 562-580.

"Map of Agua Fria Valley and the Western Portion of the Salt River Valley Showing the System of Reservoirs and Canals of the Agua Fria Water and Land Company and the Land to be Irrigated Thereby 160,000 Acres of New Land to be Reclaimed in the Maricopa County, Arizona Territory," (Brochure) Union

Photo Engraving Company. c. 1895, Salt River Project Research Archives, Tempe, Arizona.

McIntosh, R. P. "Fundamentals of the Design of a Multiple-Arch Dam," Engineering News-Record 83 (September 14, 1919): 464-468.

"Multiple Arch Dam Construction," Concrete 31 (December 1927): 43-45.

Myers, Cindy L. and Rogge, A. E. ed., "First Annual Report, Historical Archaeological Investigations at Dam Construction Camps in Central Arizona." Dames and Moore Engineering Firm, Phoenix, Arizona. (October 1987).

"The New Dam at Lake Pleasant," Progressive Arizona 4 (March 1927): 24, 33.

"Fred A. Noetzli," Transactions of the American Society of Civil Engineers 99 (1934): 1496-1497.

Noetzli, Fred A. "Improved Type of Multiple-Arch Dam," Transactions, American Society of Civil Engineers 87 (1924): 342-413.

_____. "Safeguarding the Lake Pleasant Dam," Western Construction News (April 25, 1929): 199-203.

"Official Report on Collapse of Gleno Dam," Engineering News-Record 93 (August 7, 1924): 213-215.

Peterson, W. H. "Cave Creek Flood Control Dam, Multiple Arch Structure Built Along New Lines," Southwest Builder and Contractor 62 (February 16, 1923): 30-33.

Pisani, Donald J. "Reclamation and Social Engineering in the Progressive Era," Agricultural History 57 (January 1983): 46-63.

"Proceedings Before the Board of Supervisors of the Maricopa County in Re Lake Pleasant Damn, January 4, 1929," Salt River Project Research Archives, Tempe, Arizona.

Pyle, Fred A. "Hodges Dam Strengthened," Engineering News-Record 97 (November 5, 1936): 644-647.

"Report of Joint Committee Appointed by the Senate and House Pursuant to Senate Concurrent Resolution Number 1 of the Sixth Special Session of the Eighth Legislature," January 12, 1929, Salt River Project Research Archives, Tempe, Arizona.

Schuyler, James D. "Report on the Water Supply of the Agua Fria River, and the Storage Reservoir Project of the Agua

Fria Water and Land Company For Irrigation in the Gila River Valley, Arizona," (September 29, 1903). Arizona Historical Collection, Hayden Library, Arizona State University, Tempe, Arizona. (Typewritten.)

"Schuyler, James D," Transactions of the American Society of Civil Engineers 76 (1913): 2243-2245.

Smith, Karen L. "The Campaign for Water in Central Arizona, 1890-1903," Arizona and the West 23 (Summer 1981): 127-148.

Thomas, Margaret Dudley. "Castle Hot Springs," Arizona Highways 50 (March 1974): 5-6.

"Unpleasant Truth About Pleasant Dam," The Arizona Producer (April 1, 1929): 3, 7.

"Unsafe Dam Design," Engineering News-Record 117 (November 5, 1936): 656.

Westergaard, H. M. "Cracks Observed in Dams," Western Construction News 5 (October 10, 1930): 495-497.

Winsor, Mulford. "The Moqui and Navajo Scheme," (Brochure) 1914. Arizona Historical Collection, Hayden Library, Arizona State University, Tempe, Arizona.

VI. Books

Barnes, Will C. Arizona Place Names. Revised and Enlarged by Byrd H. Granger. Tucson: The University of Arizona Press, 1960.

Carstensen, Vernon. ed., The Public Lands, Studies in the History of the Public Domain. Madison: The University of Wisconsin Press, 1963.

Faulk, Odie B. Arizona, A Short History. Norman: University of Oklahoma Press, 1970.

Fireman, Bert M. An Historical Survey of Lake Pleasant Regional Park, Maricopa County, Arizona. Phoenix: Maricopa County Park Service, 1963.

Gilbert, Bil, Westering Man, The Life of Joseph Walker. Norman, University of Oklahoma Press, 1983.

Golze, Alfred R. Reclamation in the United States. Idaho: The Caxton Printers, 1961.

Greever, William S. Arid Domain, The Santa Fe Railway and Its Western Land Grant. Stanford: Stanford University Press, 1954.

Hamilton, Patrick. The Resources of Arizona. San Francisco: A. L. Bancroft and Company, 1884.

Hammonds, Lee. Mineral and Gem Localities in Arizona. Sedona, Arizona: Arizona Maps and Books, 1977.

Hinton, Richard. Handbook to Arizona. Reprint. Glorietta, New Mexico: Rio Grande Press, Inc., 1970.

Hoffman, Abraham. Vision or Villainy. College Station, Texas: Texas A & M University Press, 1981.

International Commission on Large Dams (ICOLD). World Register of Dams. New York, 1973.

Kouwenhoven, John A. The Arts in Modern American Civilization. New York: W. W. Norton and Company, 1967. Originally published under the title, Made in America.

Lampen, Dorothy. Economic and Social Aspects of Federal Reclamation. Reprint. New York: Arno Press, 1979.

Lee, Lawrence. Reclaiming the American West: An Historiography and Guide. Santa Barbara, California: ABC-Clio, 1980.

Leland and Mereness. Introduction to the American Official Sources for the Economic and Social History of the World War. New Haven: Yale University Press, 1926.

Marshall, James. Santa Fe, The Railroad That Built an Empire. New York: Random House, 1945.

McClintock, James. Arizona. Chicago: S. J. Clark Publishing Co., 1906.

Olson, James Stuart. Herbert Hoover and the Reconstruction Finance Corporation, 1931-1933. Ames, Iowa: The Iowa State University Press, 1977.

Outland, Charles F. Man-Made Disaster, The Story of St. Francis Disaster. Glendale, California: The Arthur H. Clark Company, 1963.

Schuyler, James Dix. Reservoirs for Irrigation, Water-Power and Domestic Water-Supply. New York: John Wiley and Sons, 1908.

Sloan, Richard E. History of Arizona. Phoenix: Record Publishing Co., 1930.

Smith, Karen L. The Magnificent Experiment: Building the Salt River Reclamation Project, 1890-1917. Tucson: The University of Arizona Press, 1986.

Spude, Robert and Paher, Stanley. Central Arizona Ghost Towns. Las Vegas: Nevada Publications, 1978.

Taming of the Salt. Phoenix: Salt River Project, 1979.

Trimble, Marshall. Arizona, A Panoramic History of a Frontier State. Garden City, New York: Doubleday, 1977.

Young, Otis. Western Mining. Norman: University of Oklahoma Press, 1970.

Walker Henry P. and Bufkin, Don. Historical Atlas of Arizona. Norman: University of Oklahoma Press, 1979.

Wegmann, Edward. The Design and Construction of Dams. 8th ed. New York: John Wiley and Sons, 1927.

Worster, Donald. Rivers of Empire: Water, Aridity and the Growth of the American West. New York: Pantheon Books, 1985.